January 6, 1958

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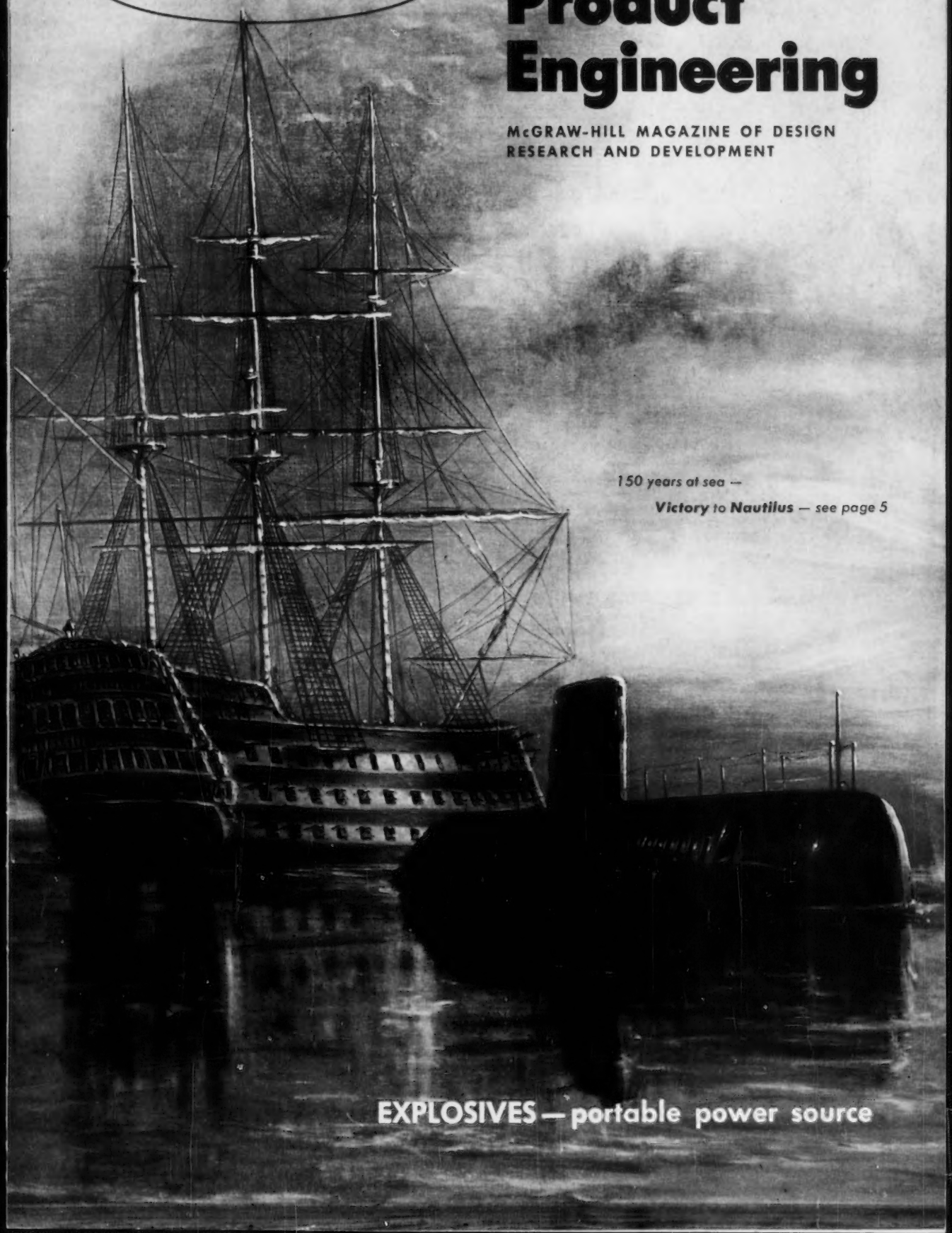
DESIGN edition

Product Engineering

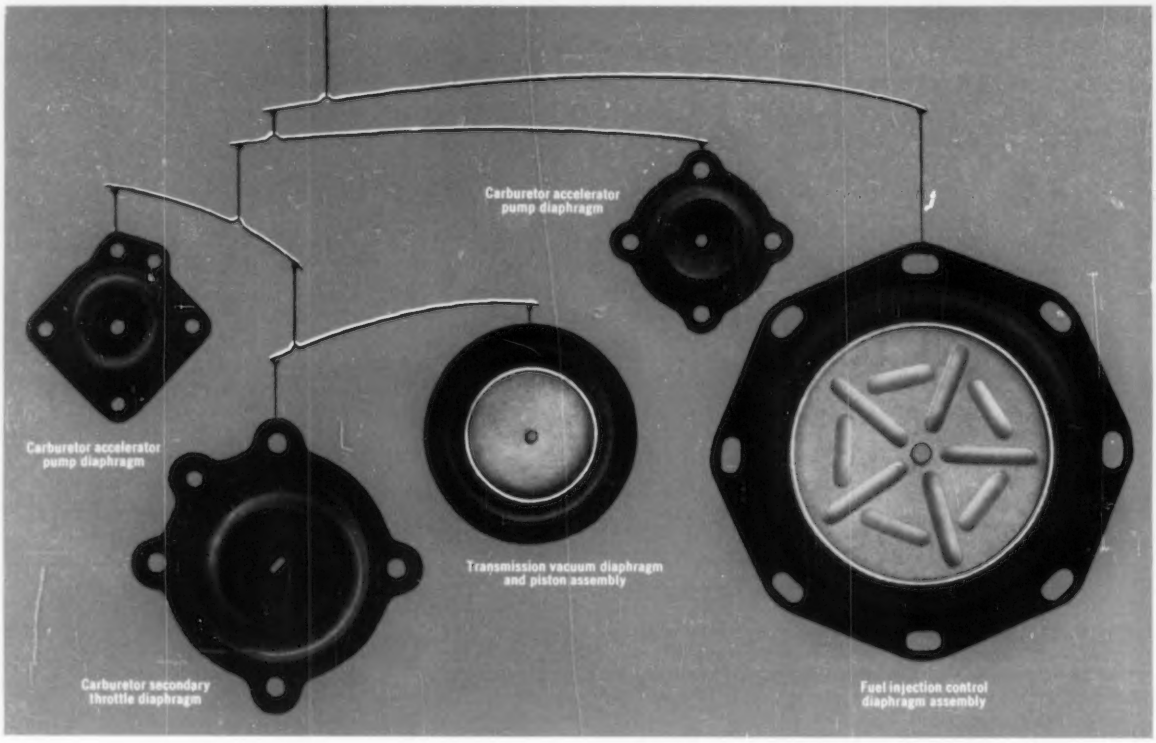
McGRAW-HILL MAGAZINE OF DESIGN RESEARCH AND DEVELOPMENT



150 years at sea —

Victory *to* ***Nautilus*** *— see page 5*

EXPLOSIVES — portable power source


Carburetor accelerator pump diaphragm
Carburetor accelerator pump diaphragm
Transmission vacuum diaphragm and piston assembly
Carburetor secondary throttle diaphragm
Fuel injection control diaphragm assembly

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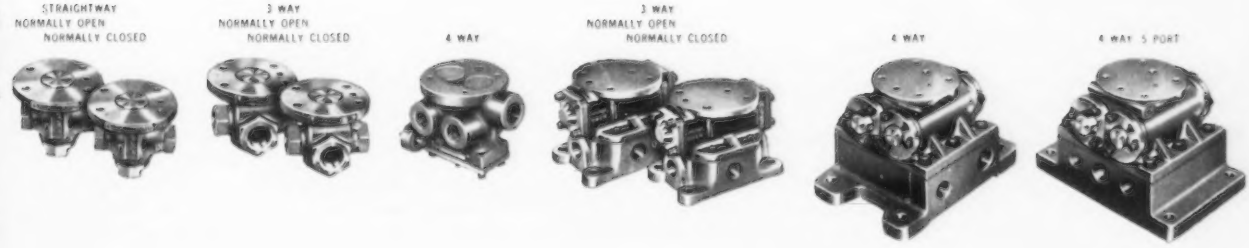
match any head to any valve body!


STRAIGHTWAY NORMALLY OPEN NORMALLY CLOSED
3 WAY NORMALLY OPEN NORMALLY CLOSED
4 WAY
3 WAY NORMALLY OPEN NORMALLY CLOSED
4 WAY
4 WAY 5 PORT

Now there are 11 heads and nine bodies to meet both usual and unique problems in the line which was designed to give you the longest life and greatest adaptability of any valve line in the world. All heads are readily interchangeable with all Skyline valve bodies, and the new Double-Stroke momentary adapter further multiplies the number of valve combinations. What is your problem? Drop us a note explaining it, or call your nearby Ross field service engineer for details on the Skyline valve to solve it.

Combining Engineering With Ingenuity for Better Air Control

Ross OPERATING VALVE COMPANY

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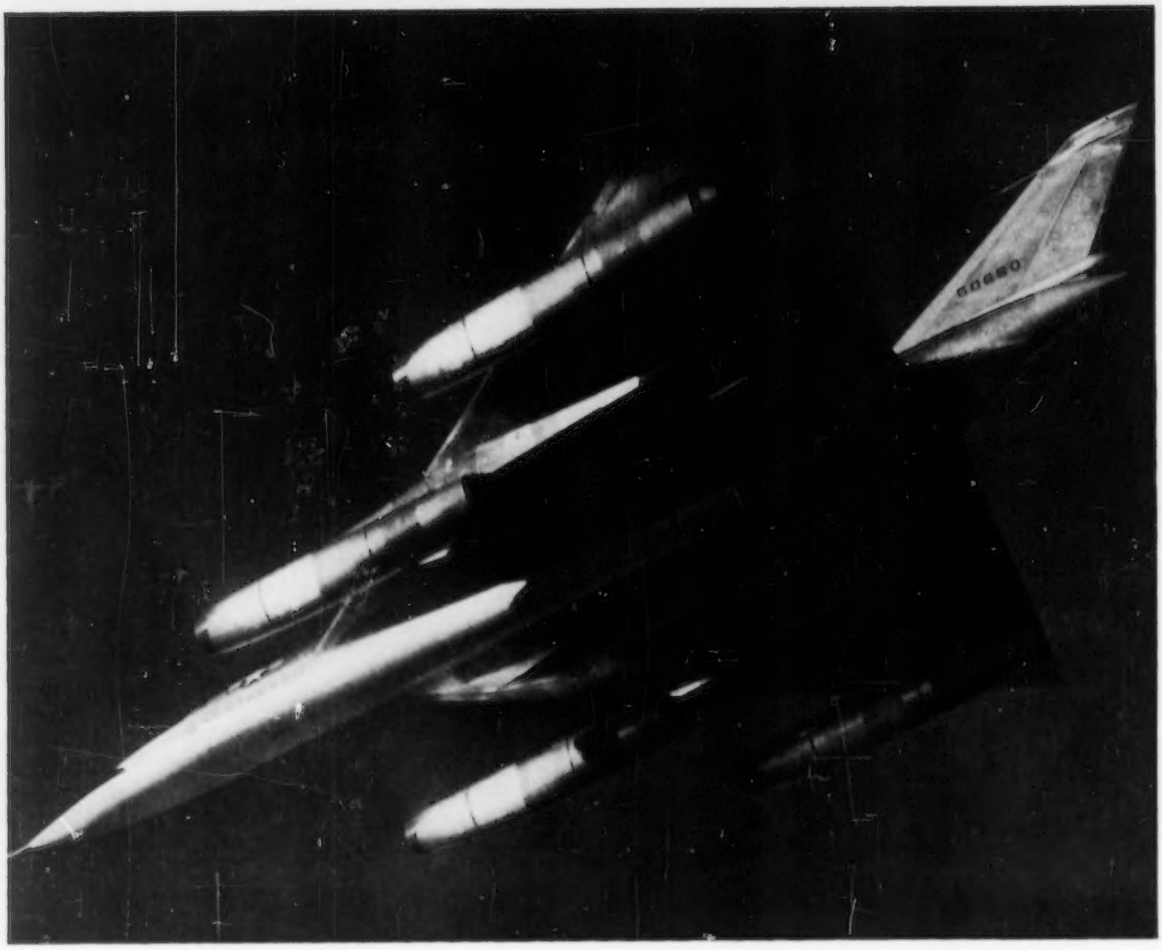

Streaking through the air faster than speed of sound, the B-58 Hustler depends upon nickel-containing stainless steel to withstand the tremendous heat developed by engine exhausts. B-58 is built by Convair, a division of General Dynamics Corporation.

How a nickel-containing stainless steel keeps Hustler from being "skinned alive"

At the speed the Hustler flies, heat from air friction is a problem.

Where this heat is amplified by heat from the powerful jet engines, the plane's skin could overheat dangerously . . . lose strength.

Convair engineers overcome this by cladding portions of the Hustler exposed to the exhaust blast with "honeycomb sandwich" panels made of a special nickel-containing stainless steel. Thin ribbons of stainless steel are formed into a honeycomb shape which is then sandwiched between two thin sheets of stainless steel.

They use 17-7PH stainless steel, produced by Armco Steel Corporation, because it has five times the yield strength of low carbon steel, and it retains much of its strength even at 900°F.

17-7PH stainless steel honeycombs provide the high strength, stiffness, and low weight needed by the Hustler as it outspeeds sound, 50,000 feet above the earth.

Does some metal problem face your staff?

Is it a problem that involves heat, cold, corrosion, wear, stresses, fatigue? Or is there some other obstacle? There's better than a fair chance we can help your engineers get off the ground. Or at least work with them to trim the problem down to manageable size. Suggest that they send for a copy of "Stainless Steel in Product Design" and an Inco analysis sheet that will help them define the problem.

THE INTERNATIONAL NICKEL COMPANY, INC.

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INCO NICKEL

NICKEL ALLOYS PERFORM BETTER LONGER

Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

JANUARY 6, 1958 Vol. 29, No. 1

STAFF REPORT

Explosives: Portable Power Packs— 56... Annesta R. Gardner, Associate Editor
Now units can be tailor-made to supply a light tap—or the thrust that will stop a runaway locomotive. Article shows how the rocket-powered and powder-actuated energy sources are being put to work.

Hot Solenoid— 61... Olin K. Smith, G. H. Leland, Inc.
Problems solved in redesigning a rotary solenoid for service at 500 F.

Pressing for Complex Shapes— 62... C. C. Higgins, Worcester Pressed Steel Co.
Any single operation in pressing is simple—and economical. But why stop there? Here is how combined operations can give complex, one-piece designs.

Fuses Do This— 64... J. C. Lebens, Bussman Manufacturing Div.
The right fuse, in the right place, at the right time, will save dollars—.naybe lives. Article analyzes different types, tells how to choose among them.

Bearings That Don't Need Press Fits— 67... E. F. Oblinger, Parker Sweeper Co.
Author describes how a penetrating liquid polymer made good as a fastener.

How Wrong Can Elastic Constants Be?— 68... S. A. Gordon, Battelle Memorial Institute
Even precise testing methods will give variations. But their effect on accurate structural design doesn't seem crucially important. Analysis shows why.

Design Features in New Products— 72... Truck goes sideways; controlled deceleration for trains; weldments in grinder frame; jet trainer redesigned.

12 Ways to Load-test Gears— 77... Gene Shipley, General Electric Co.
Until a set of gears is subjected to dynamic conditions, its performance is only guesswork. Here are a dozen methods to test gears with locked-in torque.

DESIGN FILE

How to Mount Servo Components— 86... F. W. Wood, Jr., Servonics, Inc.
Ten methods are given here, with their advantages and drawbacks.

How Much HP to Pipe Liquids?— 89... Charts give answers for flow, 50 to 100,000 gpm, for varying pipe roughness.

Starting this issue
Developments to Watch
The Engineering Week
Reader to Editor
in a special 8-page section
starting on page 33

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"ANTI-DEFLECTION" ROLLER— This large bonded rubber Tube Form Mounting is assembled between paper mill rolls and shafts to accommodate shaft deflection.

VIBRATION ISOLATING MOUNTING— Lord skill in precision manufacture is demonstrated in the production of this Tube Form Mounting with 3/8" O.D., made to extremely close tolerance and concentricity requirements. Elastomer is bonded to dissimilar metals; brass inside, stainless steel outside.

the facilities which produced these are available to solve your vibration problems

The bonded rubber tube form mountings shown are illustrative of the wide variation in size and application of vibration and shock control products designed and manufactured by LORD. The large mounting is assembled into an "anti-deflection" roller for a paper mill; the small unit is a full bonded vibration isolating mounting.

Between these extremes, LORD has produced successful solutions to tens of thousands of problems involving operating loads from a few ounces to many tons. LORD products include many shapes, and size variations from fractions of an inch to several feet. LORD has the facilities needed to produce this great variety of parts with closely coordinated research, engineering, and precision manufacturing. All of these plus LORD's extensive know-how will be applied to the solution of your vibration and shock control problems. Contact LORD at any of the Engineering Field Offices, or the Main Office, Erie, Pennsylvania.

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Interesting to Note . . .

From Wind to Atom

At Trafalgar, Oct. 21, 1805, England became in reality Queen of the Seas—the greatest maritime nation. Lord Nelson won his last and greatest victory, striding the deck of his flagship named the Victory (left). At about the same time, steam engines, destined to replace sail, were making their debut on land in England. In the 153 years since, science has progressed farther than in all the millennia before—exemplified by the Nautilus, first nuclear-powered submarine. Now wind, coal and oil must all yield to the nucleus, the world's greatest power source—in fact, its greatest natural resource. Properly governed, the center of the atom has potential for peacetime applications that strain the imagination of the best scientists.

Our cover is reproduced from a painting by Richard S. Frankel, secretary-treasurer of Nuclear Science & Engineering Corp., Pittsburgh, subsidiary of Norden-Ketay Corporation. Mr. Frankel was staff assistant in the reactor and materials departments and staff assistant to the director of research, Westinghouse Atomic Power Division. A professional engineer, Mr. Frankel has his BS in industrial-mechanical engineering from the University of Michigan and did graduate work at the University of Pittsburgh.

The First Missile

Intercontinental missiles, intermediate range missiles, guided missiles—where will it all lead? Well, one man who could give a good answer to the multi-missile question is President Eisenhower's special assistant for Science and Technology, Dr. James Killian. Some of his views are expressed on page 51.

Actually, the first guided missile was the arrow. Probably invented by the cave folk some 10,000 years ago, it is still considered the most dangerous of all missiles for its weight. Strange as this may seem, it has been estimated that 5000 men were killed by arrows in World War II. Many of them were sentries slain silently by an arrow by British Commandos raiding into Germany and Scandinavia.

The penetration of the arrow even today is quite remarkable. Ask the deer hunter who has put his rifle over the fireplace and taken up bow and arrow. A hit on any part of the body is almost sure death. The arrow doesn't inflict a clean wound, and removal is most dangerous. The Plains Indians would secure the head to

(Continued on page 7)

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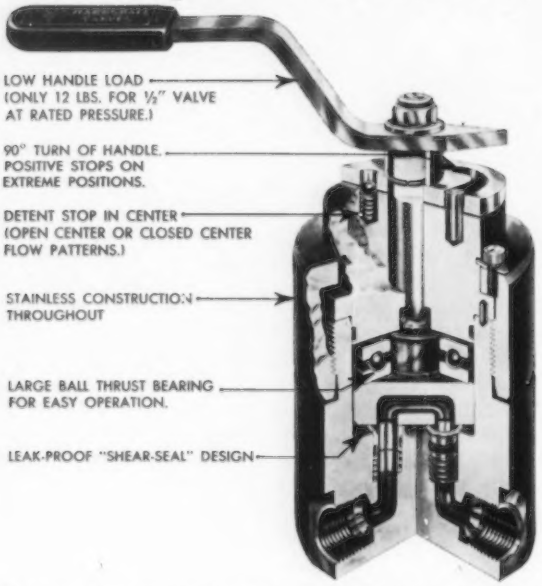
4 WAY VALVE

FOR LIQUIDS OR GASES


LOW HANDLE LOAD (ONLY 12 LBS. FOR ½" VALVE AT RATED PRESSURE.)
90° TURN OF HANDLE. POSITIVE STOPS ON EXTREME POSITIONS.
DETENT STOP IN CENTER (OPEN CENTER OR CLOSED CENTER FLOW PATTERNS.)
STAINLESS CONSTRUCTION THROUGHOUT
LARGE BALL THRUST BEARING FOR EASY OPERATION.
LEAK-PROOF "SHEAR-SEAL" DESIGN

This new four-way valve series comes in pipe sizes from ¼ to 1 inch, but may be obtained with tube, AND 10050, or any preferred special high pressure connection. It will withstand surges of up to 15,000 P.S.I. without damage to the valve's sealing qualities. It is designed for a burst pressure of 30,000 P.S.I.

No port to port leakage occurs in the detented positions because of the exclusive "Shear-Seal" design.

Long, maintenance-free service is assured because the optically flat metal to metal sealing surfaces of the sealing rings and mating rotor faces are protected by staying in constant intimate contact; flow is always through the center of the "Shear-Seal", never across sealing surfaces (as in conventional valve design). Sealing qualities actually improve as the self aligning "Shear-Seals" lap themselves to a more perfect fit with each valve operation.

Of course, there is no external shaft leakage, because the pressure is confined to the flow passages.

This highly successful principle of extreme pressure control is fully described in "Shear-Seal" bulletin BVM-2.

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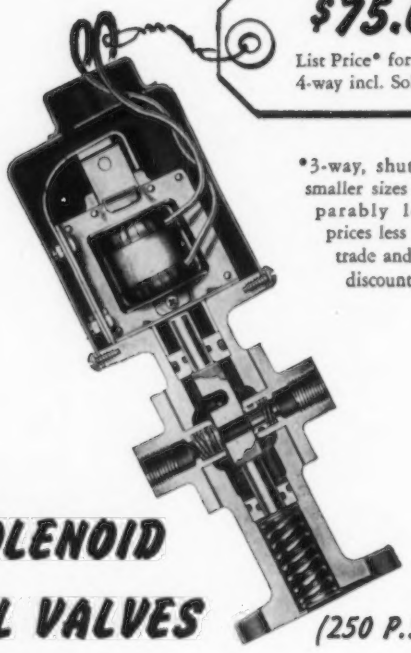
LEAKPROOF (SHEAR-SEAL)

$75.00
List Price* for a ½" 4-way incl. Solenoid



*3-way, shut-off and smaller sizes are comparably less. All prices less the usual trade and quantity discounts.

SOLENOID OIL VALVES (250 P.S.I.)

WHERE	WHY	HOW
Thread rolling machines	Holding position (leakproof)	Lapped sealing surfaces seal tight indefinitely as a result of wear compensation
Pressure testing in automotive production	Oil gets contaminated by scale in castings (not critical to dirt) reduced maintenance	Sealing surfaces in constant, intimate contact, dirt can't lock valving members – saves coil burn-out
Hydraulic work feed apparatus	(Leakproof) . . . as versus spool valves which cause overdemand on hydraulic system	Positive shut off of internal port to port leakage and of course, no external leakage
Machine tool chucking & clamping	Maintaining safe holding pressure (leakproof)	Saving auxiliary equipment such as pilot operated check valves
Automatic door openers	Quick action (high flow capacity)	No spools or poppets obstructing full, round flow passages
Solenoid controlled hydraulic system on machine you build	Better performance Lower manufacturing costs Reduce service problems	Shear-Seal valves have full flow, are leakproof, not sensitive to dirt Low priced, less auxiliary equipment and labor cost. Valves don't stick, saving coil burn-out; stay leakproof indefinitely, seals are wear compensating

BARKSDALE VALVES

5125 Alcoa Avenue, Los Angeles 58, California
Ask for bulletin 5S-H

the shaft with sinew. Body heat would melt the sinew, leaving a victim with an arrowhead imbedded in his body. The arrow had a psychological effect as well. A warrior with a 12-in. shaft protruding from even a non-fatal portion of his body didn't feel much like continuing the battle.

Biggest Gun in the World

Today more than ever, the world is aware of the feasibility of firing a projectile over 5000 miles. The expression "a shot heard round the world," could easily become—shot fired round the world. However, the concept of a shell traveling more than 65 miles was still in the realm of dreams before the modern missile came into being. Some naval vessels had 16-in. rifles that could approach the 30-mile mark, Germany's Big Bertha once hit a target 25 miles away, but that was about the limit of a fixed artillery piece. No wonder the French were so alarmed at the close of World War I when it was learned that the Germans were firing on Paris from over 65 miles away. The Ministry of Information didn't report what was actually happening. In its first communique, it only stated that Paris was being bombed by a new high-altitude plane. The people accepted this for a few hours, but soon the truth seeped out.

On March 23, 1918, the first shot was fired. It dropped on a quiet dawn-lit street and blasted cobblestones through a few store fronts. It was thought to be a grenade or time bomb. The second shell was not accepted as serenely. It hit a subway station around 8 o'clock in the morning. Of the rush-hour crowd, 21 never got to work that day—the first victims of the world's biggest gun.

Through the technical know-how of Dr. Otto von Eberhardt of the Krupp Co., the monster gun was designed with a 98-ft rifled barrel. For the necessary muzzle velocity of 1 mile/sec a breech pressure of 70,000 lbs/sq-in. was needed—a tremendous demand on an explosive. (An article discussing explosives as portable power packs begins on page 56.) Fortunately the war ended before the bombardment could really become effective. Total damage with the world's largest gun: 367 shells fired; 256 killed; 640 wounded; property damage, $10 million.

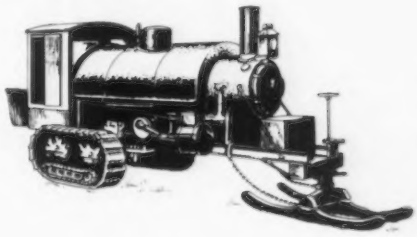
That Pesky Fuse

"It *would* have to blow now; how will I find out who won the game?" How many times has the right fuse blown at the wrong time? The electric range goes out with a roast in the oven and the boss over for dinner; or, the lights go out with the detective just ready to name the killer. Changing and selecting house fuses is relatively simple today—even the wife can do it. What about fuses for complex electric circuits? Perhaps the article on page 64 can help you out.

One of the best examples of a fuse blowing at the wrong time occurred soon after the turn of the century. Frank J. Sprague was demonstrating the advantages of electric traction on Manhattan's elevated lines to their principal backer, the late Jay Gould. Everything seemed in order. Gould was wined and dined and fed a diet of the best public relations available. By the time he stepped aboard the electric car he believed that this was indeed a worthwhile project in which his sharp-shooting financial genius could invest.

He stood behind the controller and mused how nice it would be to control the moving machine on a track above the city. His vicarious visions were suddenly interrupted with the blinding flash of a fagged-out fuse. In the confusion that followed, Gould was saved, by an alert aid, from leaping off the stalled car to the street below. Needless to say electric traction no longer interested magnate Jay Gould.

Snow Use



"Winters sure ain't like they used to be," a weather-worn New Englander told me not too long ago. "Why back in '97 we had snow so deep in these Maine woods, horses had to wear snowshoes to haul timber to the mill." This may be somewhat of an exaggeration; however, removing heavy logs from a dense wooded area is hard enough with a team of horses even in summer—and snow and cold just add to the burden. When mechanization swept New England's saw and pulp mills, it was wished that someone would come up with an easier way to get the timber from woods to mill when river log-drives couldn't get through solid ice.

In 1899, the hope was fulfilled by an ingenious "Maineiac" named Alvin O. Lombard. At the time, he was living in Waterville, (home of now-modern Colby College) when he met E. J. Lawrence, head of the Lawrence Kennebec Lumbering Co. Lombard had previously invented a turbine waterwheel control unit, a log debarker and a method of separating chipped wood from knots and sawdust. He was asked to try his inventive genius to find a mechanical way to haul logs through heavy snow. As a result of his talk with Lawrence, Lombard built a 15-ton log hauler that resembled a locomotive.

To find a driving mechanism that would not stick or slip in the snow was Lombard's main problem. He solved it by designing the first Caterpillar tread—a wide continuous belt with lugs for gripping snow. The treads passed over four driving wheels, two on each end of the hauler.

The evolution of transport has brought us to the situation described on page 72, a truck that can move sideways, as well as forward and reverse.

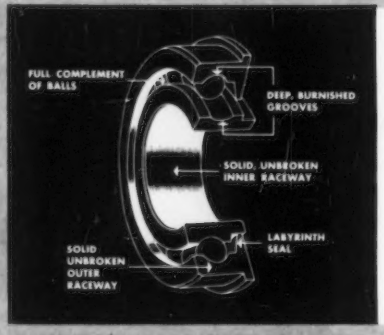
—Benedict A. Leeburger Jr.

THE NEW HEIM Unibal® BALL BEARING

This new, ingenious method of ball bearing assembly means . . .

Lower Prices

The simplicity of its construction avoids costly, extra assembly devices and results in fewer component parts, which fit together easily to form a smooth running bearing. Unibal is a premium quality commercial ball bearing, delivering superb performance at prices substantially lower than ground ball bearings.



Compared with conventional commercial ball bearings, longer life is attained and both radial and axial load capacities are increased by the sturdy, one-piece raceway construction.

Note this unusual construction (patents pending):

- Solid, unbroken, machined outer and inner raceways.
- Deep, burnished ball grooves with a full complement of balls.
- Both raceways are deep carburized and hardened.
- Labyrinth seals on one or both sides.

Available in single row, double row, with or without flanges; extremely narrow widths and small diameters; to close tolerances and controlled radial and axial play.

HEIM is also the originator of the Unibal® Spherical Bearing Rod End.

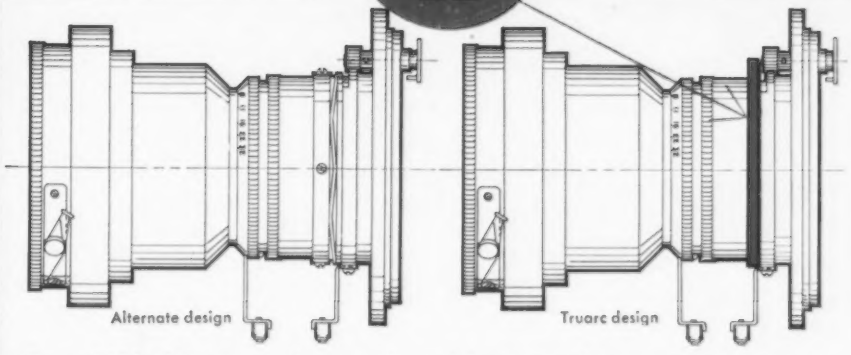
Write for catalog and special bulletin with load ratings and dimensions.

Manufactured by THE HEIM COMPANY for Universal Bearing Corp.
FAIRFIELD, CONNECTICUT

Waldes Truarc Retaining Ring eliminates 7 parts, saves $8.88 in sub-assembly of aerial reconnaissance camera

Gordon Enterprises, No. Hollywood, California, saved the Navy almost 1½ million dollars on 500 cameras. Gordon rebuilt new, efficient "CA" series out of Navy-owned obsolete models. Critical parts are now held together by Waldes Truarc Retaining Rings.

Truarc Rings are trouble-free, will not change position during operation. Accuracy is limited only by groove and ring dimension tolerances. And standardized Truarc Rings are quickly interchangeable in overhaul which now takes only 11 minutes, can be handled by unskilled technicians.



Truarc 5100-287 ring retains shutter speed adjustment mechanism on the Lens Adapter Plate Assembly which mounts and locks the lens and shutter assemblies accurately to camera body. Alternate design required retaining washer, spring, collar and 4 locking screws.

Weight Saving: 7.25 oz.

Assembly Time Saving: . . . . . 6½ min.

DOLLAR SAVINGS:

Material	**$ .93**
Fabrication	**6.88**
Inspection	**1.07**
Total	**$8.88**

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Controlled Quality from engineering and raw materials through to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool!

WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC.

47-16 AUSTEL PLACE, L. I. C. 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send new, descriptive catalog showing all types of Truarc rings and representative case history applications. *(Please print)*

Name _____

Title _____

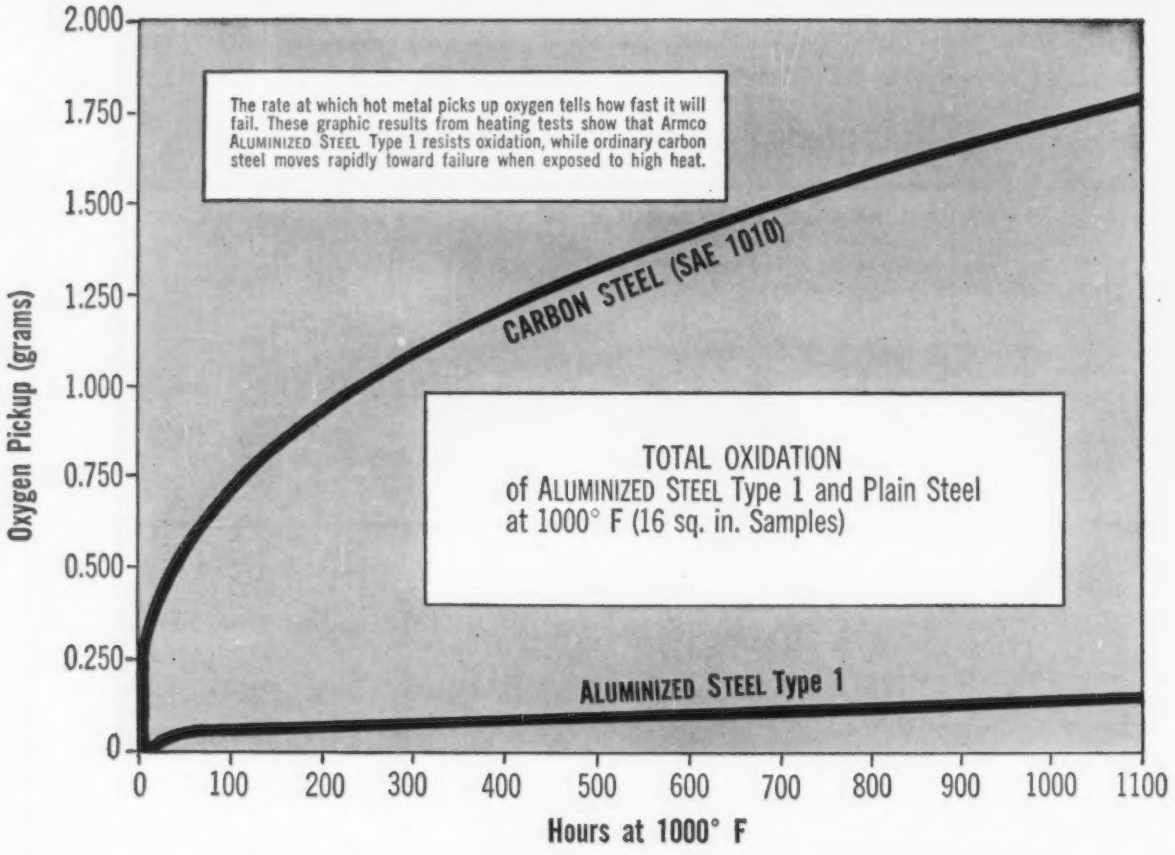
Company _____

Business Address _____

City _____ *Zone* *State*

PN 010

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.


The rate at which hot metal picks up oxygen tells how fast it will fail. These graphic results from heating tests show that Armco ALUMINIZED STEEL Type 1 resists oxidation, while ordinary carbon steel moves rapidly toward failure when exposed to high heat.
CARBON STEEL (SAE 1010)
TOTAL OXIDATION
of ALUMINIZED STEEL Type 1 and Plain Steel
at 1000° F (16 sq. in. Samples)
ALUMINIZED STEEL Type 1
Oxygen Pickup (grams)
2.000
1.750
1.500
1.250
1.000
0.750
0.500
0.250
0
0 100 200 300 400 500 600 700 800 900 1000 1100
Hours at 1000° F

Test Shows How Well Armco ALUMINIZED STEEL Resists Heat

Armco ALUMINIZED STEEL® Type 1 (steel hot-dip coated with aluminum) stands up to heat because it withstands destructive scaling. This test shows how well.

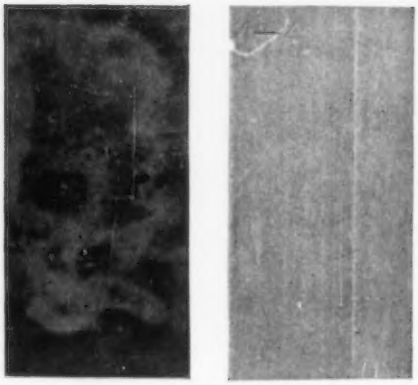
Above 900 F, an iron-aluminum alloy forms on the surface of Armco ALUMINIZED STEEL Type 1. It becomes a tightly-adherent refractory material that protects the base metal. Ordinary carbon steel lacks this protection. The powdery and flaky oxides which form on the surface of carbon steel fall away, exposing it to further attack.

Economical Double Protection

Armco ALUMINIZED STEEL Type 1 not only resists heat, it fights corrosion at the same time. In fact, this special 2-in-1 metal beats back deadly combinations of heat and corrosion better than any metal in its price class.

If parts of your products are exposed to a combination of heat and corrosion, it may pay you to get all the facts about Armco ALUMINIZED STEEL Type 1. It could be a low-cost solution for your problems.

Complete information on this special coated steel is readily available. Just call your nearby Armco Sales Office or write us at the address below.



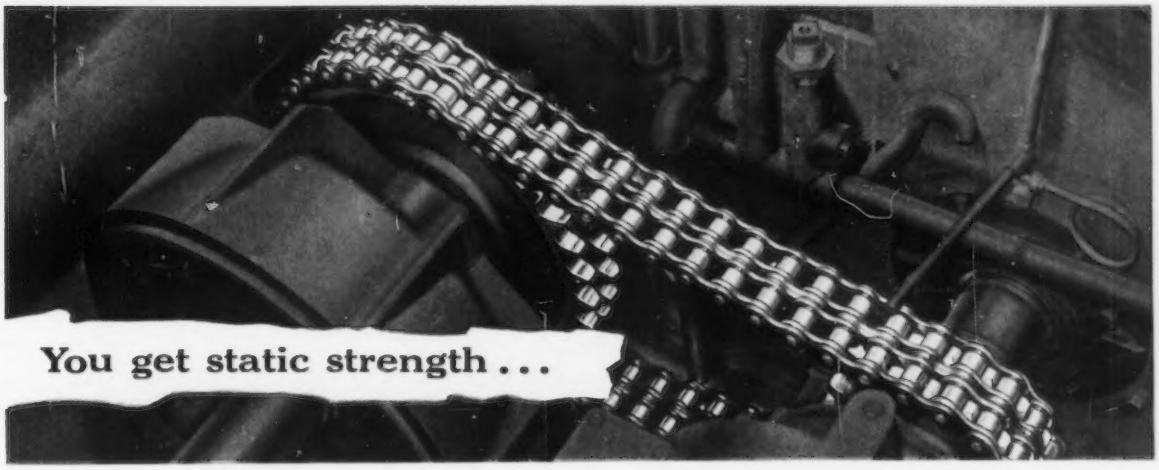
After 1100 hours at 1000 F. **Right**—Armco ALUMINIZED STEEL Type 1; **Left**—SAE 1010 Steel.

ARMCO STEEL CORPORATION

1537 CURTIS STREET, MIDDLETOWN, OHIO

SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

Why tough-service drive and conveyor jobs demand LINK-BELT roller chain



RESISTANCE TO TENSILE STRESS is achieved with properly heat-treated, accurately machined side bars made of premium steel and fitted with properly hardened pins, bushings, rollers.

STRENGTH OF CHAIN IN MOTION results from such refinements as pitch-hole preparation, micro-finish of parts, special processing of side bars, pre-lubrication, rigid quality control.

THE *greater dynamic strength* found in Link-Belt precision steel roller chain is essential for long life on today's harder-working drives and conveyors. This added capacity to resist shock loads, centrifugal loads and similar stresses is achieved only because Link-Belt adds refinements in manufacture.

These include lock-type bushings, shot-peened rollers, pre-stressing, closer heat-treat control. The result: a precision chain that takes stresses in stride . . . provides smoother, more efficient performance that measurably outlasts ordinary roller chain — reduces costs.

For full data on Link-Belt roller chain and engineering application assistance get in touch with your nearby Link-Belt office.

LINK-BELT

ROLLER CHAIN & SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14.470-A

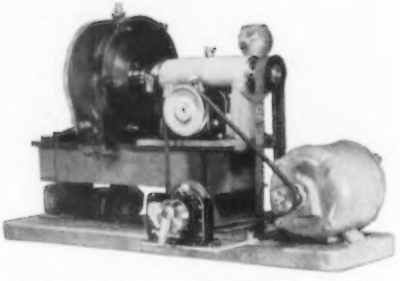
Automatic transmission seal problem—

New National Syntech® proves dependable answer in front pump seal position

Constant temperatures of 250°F, peaks of 300°, continual change in shaft speed, and total inaccessibility of the seal without costly teardown—these are a few of the sealing problems in the front pump of today's automatic transmissions for passenger cars.

To help meet this challenge, National engineers have produced a new oil seal. The new design, a steel encased, spring-loaded unit with Syntech synthetic sealing lip, is characterized by an unusually long flex section in the lip, a special, light-loading tension spring, and the time-tested, low torque Syntech lip itself.

Factory engineers report that the new National seals are proving extremely reliable in the application. Dealers also find the front pump seals are very reliable and do not require early replacement.



To design and thoroughly test the new seal, National engineers developed a new transmission simulator which exactly duplicates front pump operating conditions at all car speeds.

Get real help on seal engineering problems. Call the National Engineer.

NATIONAL SEAL Division, Federal-Mogul-Bower Bearings, Inc.

General Offices: Redwood City, California; Plants: Van Wert, Ohio, Downey and Redwood City, California

how to keep costs down

...profit margins up!

ALLEN Engineers will show you how you can save time and money by using standard* ALLEN Hex-Socket Cap and Set Screws instead of specials.

Let's get this straight right away... if your product design MUST have special cap or set screws, then ALLEN's the place to come for them.

But our engineers have found, from a good many years of experience, that designs frequently call for *special* hex-socket cap and set screws that are only slightly "off-standard." These specials take longer to get, cost more.

Allen engineers can probably save *you* both time and money by working with you on ways to use *standard* Allen Hex-Socket Cap and Set Screws, where specials may seem to be necessary. Just send blue prints, or good descriptions, of your product designs to our Engineering Department, or talk with your Allen Field Representative.

*ALLEN **manufactures 1457 *standard* items**

Stocked and sold by leading industrial distributors everywhere

ALLEN MANUFACTURING COMPANY
Hartford 2, Connecticut, U.S.A.

ALLEN HEX-SOCKET SCREWS HEAD

Note—Commercial and Military Packaging Engineers:

LINK-LOCK

...is the rugged answer to your exacting container closure problems

LINK-LOCK plays an important role in the design of this container

Simmons' LINK-LOCK provides pressure-tight, impact-resistant closure, plus quick closing and opening, on this reinforced fibrous plastic product made by the new automatic pre-form process developed by Pressurform Container Corp. The two-section container will be used by the Light Military Electronic Equipment Dept. of General Electric Company for shipping airborne radar jamming units to the Air Force.

Of prime importance are the container's lightness, strength, rust- and mildew-resistance, ability to withstand high pressures without distortion, ease of locking and opening, and low cost.

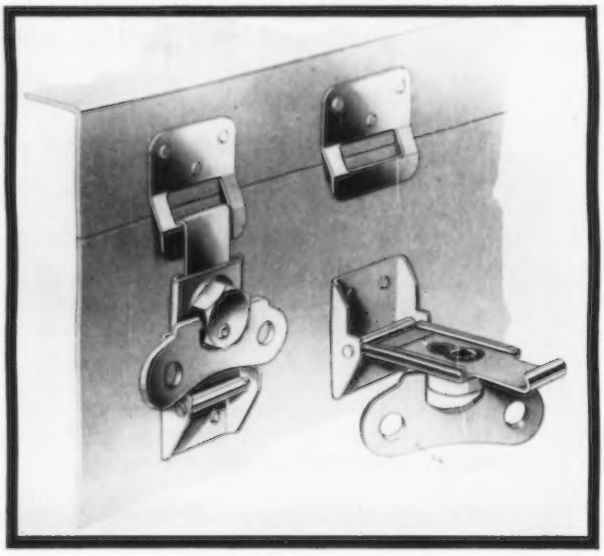
Here's why LINK-LOCK is ideal for use on military cases produced to exacting specifications as well as on inexpensive commercial containers:

- High closing pressure with light operating torque... insures pressure-tight seals where required.
- Impact and shock resistant (positive-locking).
- Compact design...lays flat against case even when unlocked.
- Available in 3 sizes, for heavy, medium, and light duty.
- Opening and closing by wing-nut, screwhead, or hex nut.
- Flexible engagement latch design...can be varied to suit different conditions.

Also available! Spring-Loaded LINK-LOCK... ideal for less expensive containers where costs won't permit precision production. Spring provides take-up to compensate for set in gasketing, irregularities of sealing surfaces, and mounting inaccuracies.

Where does the versatile Simmons LINK-LOCK belong in your design? For full information and specifications, send for LINK-LOCK DATA SHEETS today. Samples and engineering service available upon request.

Courtesy of Pressurform Container Corp., and the LMEE Dept. of General Electric Co.



SIMMONS
FASTENER CORPORATION

1751 North Broadway, Albany 1, New York

QUICK-LOCK SPRING-LOCK ROTO-LOCK LINK-LOCK DUAL-LOCK

See our 8 page Catalog in Sweet's 1958 Product Design File

What to do when your "baby" develops sales appeal overnight

Don't push the panic button. Call THE MAN FROM INTERNATIONAL for very special delivery service of very special product power

Naturally, you should be very proud when your new pilot model performs exactly the way you hoped it would when you finalized the blueprints. But your product plans should also provide for ways of supplying the sales department with prompt production when the sales manager tells you your "baby" has developed terrific sales appeal, almost overnight.

This isn't the time to press the panic button. It's time to call in THE MAN FROM INTERNATIONAL. You can count on him to help you out of any tight spot, especially one like this. He can provide very special delivery service on dependable International engines sized and powered not only for your pilot models but also for quantity production. He sells 20 diesel and carbureted engines you can put in your product and forget about from a service standpoint. And he can deliver any of them fast.

Give him a ring at his headquarters in Melrose Park, Illinois—Fillmore 3-1800—today. You'll find him extremely helpful in solving any production problem that calls for fine engines delivered without red tape. And you'll find the customer-pleasing power he sells will even make your sales manager happy.

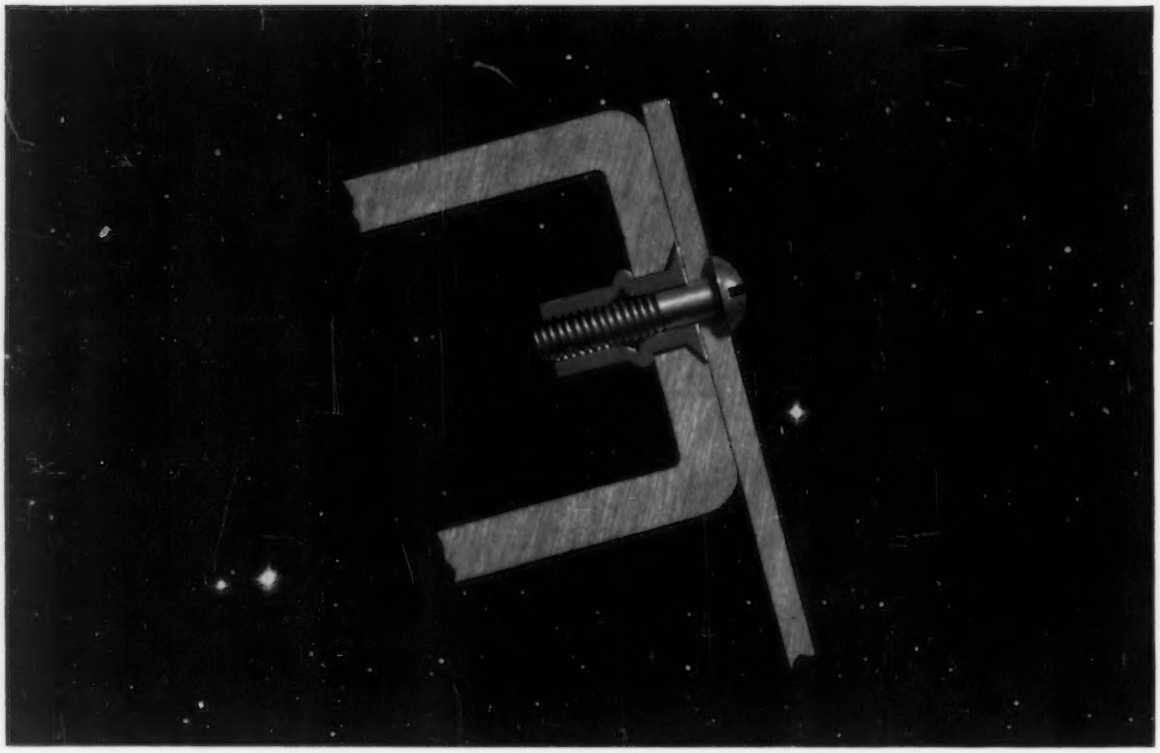
INTERNATIONAL®

International Harvester Company
180 North Michigan Ave., Chicago 1, Ill.

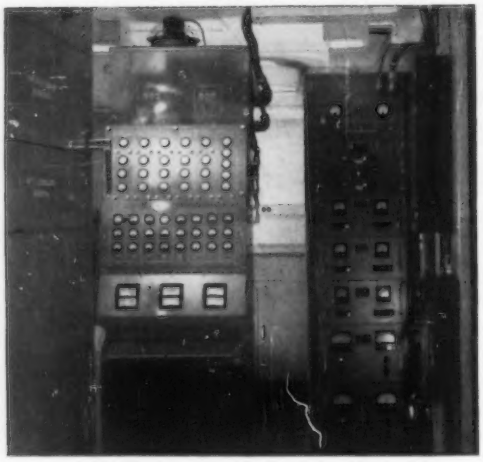
CONSTRUCTION EQUIPMENT

A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors... Self-Propelled Scrapers... Crawler and Rubber-Tired Loaders... Off-Highway Haulers... Diesel and Carbureted Engines... Motor Trucks... Farm Tractors and Equipment.

B.F. Goodrich Rivnuts® help fasten electronic "ears" that track orbits of man-made moons



Rivnuts provide sturdy blind nutplates for ultra-sensitive equipment that will receive radio impulses from Vanguard Satellite



During the International Geophysical Year, scientists will launch the first American satellite, the Vanguard. To track its orbit around the earth, "Minitrack" stations in North and South America will receive radio signals from the satellite itself, magnify them with ultra-sensitive receivers, and relay position information to the Vanguard Computing Center in Washington.

The photograph (left) shows the inside of a "Minitrack" station, with the receiver rack in the center. Fastening the face panels on this rack posed a problem for Bendix Radio Division, manufacturers of the equipment. Because the frame is made of square tubular aluminum for greater strength, ordinary nuts and bolts could not do the job.

Bendix found the answer in B.F.Goodrich Rivnuts, which provided sturdy, blind nutplates, easy and economical to install. Whatever you manufacture, from complex electronic equipment to simple sheet metal assemblies, B. F. Goodrich Rivnuts may be the answer to your most puzzling fastening problems.

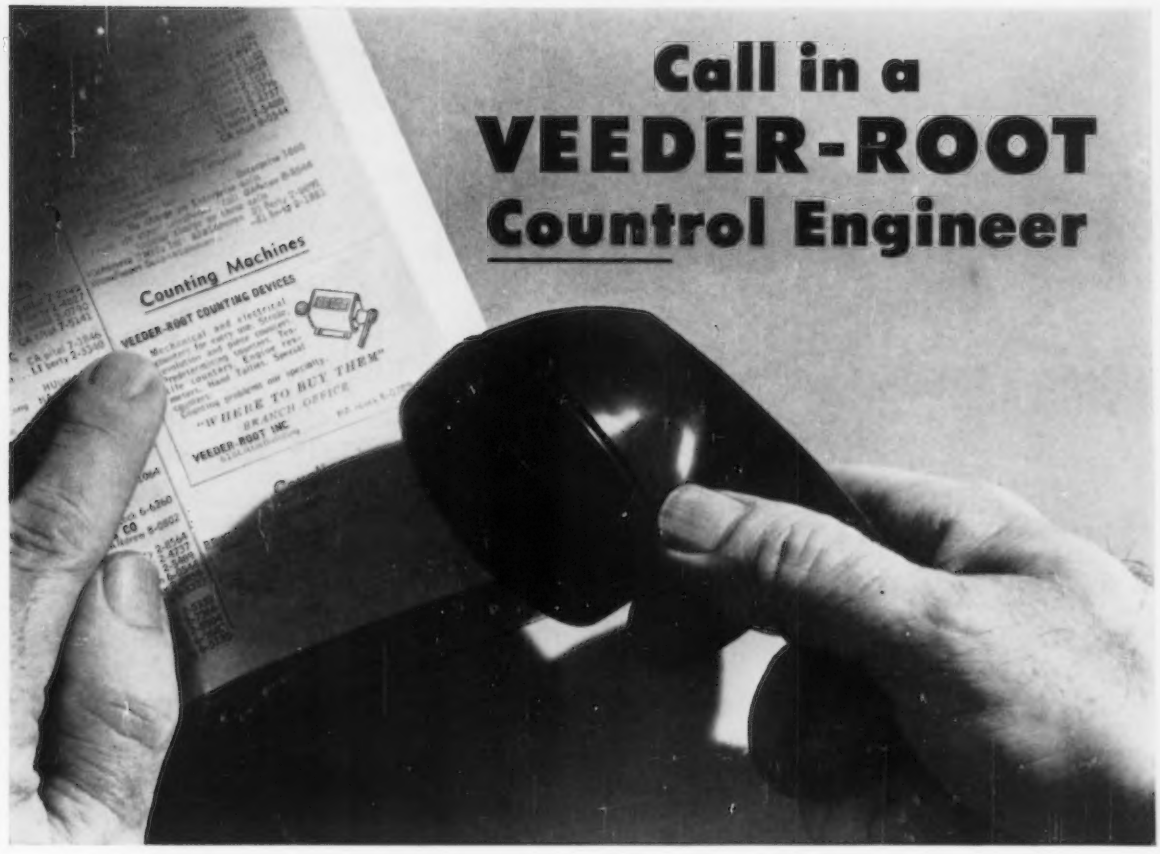
Write for free Rivnut demonstrator, Dept. PE-18

B.F.Goodrich

B.F.Goodrich Aviation Products

a division of The B. F. Goodrich Company, Akron, Ohio

When it comes to Counting...PUT "first things first!"



"Design them in, when you begin" . . . that's the way to *integrate* Veeder-Root Counters into a new product or process. And the quick way to do this is call the nearest Veeder-Root office and ask for an engineer.

You can count on this man to save you time and money in engineering, purchasing and assembly. For he can often save you the premium cost of a special counter by adapting or modifying a standard counter to do the job you want done . . . whether it's to give you or your customers direct readings . . . remote indication . . . facts-in-figures for production, wage-payment or stock *Countrol* . . . or proof of performance-guarantee.

So when it comes to counting, call the local office or the Hartford plant, JAckson 7-7201.

Veeder-Root

INCORPORATED

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New York • Los Angeles • San Francisco • Montreal
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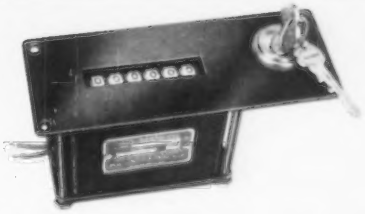
NEW ADDITIONS TO THE MOST COMPLETE LINE OF ELECTRICAL, MECHANICAL & MANUAL COUNTERS

New Electric Predetermining Counter

New Printed-Circuit Data Readout Counter



New Panel-Mount Magnetic Counter with Lock-Key Reset

Republic ELECTRUNITE

WHEN IT'S MOVING, MAKE IT TUBING . . . a Republic engineering principle that improves sales and profits for manufacturers. This simple 2½-inch bearing liner made of Republic ELECTRUNITE Stainless Steel Tubing is featured in the new "Highlander" Automatic Washer developed by the Maytag Company to meet the needs and requests of budget-conscious young Americans.

REPUBLIC

REPUBLIC STEEL

World's Widest Range of Standard Steels

Stainless Steel Tubing... helps MAYTAG bid for Big Volume Sales

Engineering innovations such as this switch to Republic ELECTRUNITE® Stainless Steel Tubing made it possible for the Maytag Company to produce its new "Highlander". This automatic washer is priced to meet the needs and demands of budget-conscious young Americans without sacrificing quality found in top-of-the-line models.

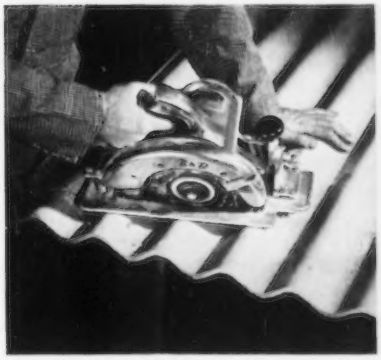
It's a simple 2½-inch bearing liner. But, it saves Maytag money.

Republic ELECTRUNITE Stainless Steel Tubing provides greater true concentricity than the tubing formerly used. There is no need for buying a heavier wall and then spending more money to remove stock.

Tubing originally purchased was .187″ wall thickness. By utilizing the concentricity of ELECTRUNITE they were able to reduce the wall to .083″.

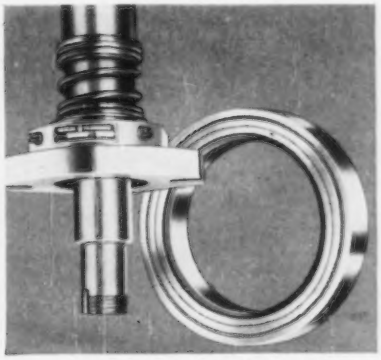
And, they get the rust-and-corrosion-resistance that only stainless steel can offer. This is vital because the tube becomes the outer shell of the main agitator bearing. It must operate for the *life of the washer* with no further lubrication than originally supplied.

Welded stainless steel tubing can save you money and hold quality high. Especially when it's ELECTRUNITE—uniformly round, uniform in wall thickness, free from defects, resistant to rust and corrosion, easily fabricated, strong, tough. And, produced by Steel and Tubes—the pioneer in electrically welded tubing. Let us show you where it can cut costs, improve quality in your products, processes and plants. Write for additional information today.



HEAVY-DUTY PERFORMANCE and reliability have played a major part in establishing product reputation for The Black & Decker Manufacturing Company, Towson, Maryland. Strong, long-lasting gears made from Republic Cold Finished Alloy Steel meet the heavy duty service requirements in this Black & Decker portable electric saw. And exceptionally high strength-to-weight ratio permits design of thinner sections to save weight and hold down size without sacrifice of strength. These are but a few advantages Republic Cold Finished Alloy Steel may offer you in your operations. For complete details write today.

REPUBLIC ELECTRO PAINTLOK, used for these water cooler housings, or for exterior panels of ranges, freezers, dryers, washers, air-conditioners and other major appliances and cabinets for home, commercial and industrial applications, provide an excellent paint-gripping surface for greater finish economy. Produced by electro-galvanizing and a chemical treatment process, Electro Paintlok Sheets are shipped from the mill in prime condition for painting. Even if final finish is scratched through, this coating limits corrosion to the point of damage. For additional data and complete details, send coupon.



REPUBLIC ENDURO® STAINLESS STEEL BARS develop a machine finish that looks as good as a ground finish—is the performance report from machine operators at Sealol Corporation, Providence, Rhode Island. This company used Free-Machining ENDURO bars in the manufacture of mechanical shaft seals for applications on fuel tankers, and in the food, chemical, aircraft and petroleum industries. Sealol machine operators like the machinability of ENDURO Stainless Steel Bars—the fine surface finish, the accuracy of section, the uniform soundness, and the ability of ENDURO to hold close tolerances. Send coupon today.

STEEL

and Steel Products

REPUBLIC STEEL CORPORATION
DEPT. C-4634
3150 EAST 45TH STREET • CLEVELAND 27, OHIO

Please send additional information for the following:

- ☐ Republic ELECTRUNITE Stainless Steel Tubing
- ☐ Republic Cold Finished Alloy Steel
- ☐ Republic Electro Paintlok
- ☐ Republic ENDURO Stainless Steel

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

HOW CENTRAL FOUNDRY FERROUS

Shell Castings

reduce machining time, increase tool life and greatly improve flexibility of design

DIMENSIONAL ACCURACY is one of the main advantages of a casting made from a shell mold. Shell castings give excellent duplication of detail since the curing of the shell on the pattern produces a hard, smooth mold which is as accurate as the pattern itself.

MACHINING COSTS are reduced with shell castings because casting dimensions are so close to the finished part that less material needs to be removed. Rough turning and milling operations can often be completely eliminated. Since intricate molds are possible in shell molding, holes often may be cast in . . . thus eliminating core-drilling. Because of their uniformity, shell castings are well suited to automatic loading and unloading.

Since shell castings are free from surface-sand, they reduce wear on turning tools, chucking jaws and fixtures. Records show that the life of these tools may increase from 1 to 3 times with sand-free shell castings.

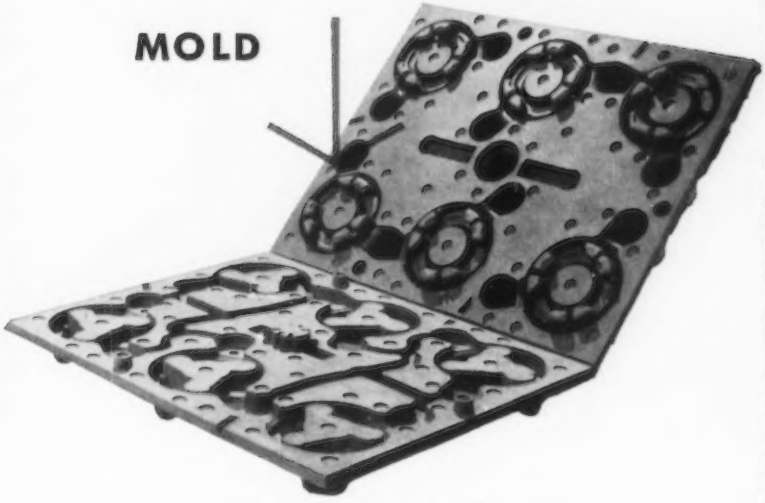
DESIGN FLEXIBILITY is increased with the shell mold process. Engineers can design for complex core-recesses and deep pockets, which would be impossible by any other method. The transmission governor body shown on the opposite page, illustrates this flexibility of design offered by shell castings.

To reduce machine time, increase tool life and greatly increase design flexibility, specify Central Foundry Shell Castings for your products. Available in grey iron, alloy grey iron, malleable iron or ARMASTEEL.

Write for your free copies of these two factual books about SHELL CASTINGS and ARMASTEEL®. Our research and engineering staff is available with the latest improved foundry methods . . . spectro-analysis, stress analysis and sonic testing . . . to help you seek a solution to your casting problems.

THIS CLEAN, SHARP

MOLD



PRODUCES THESE CLEAN,

SMOOTH, SHARP CASTINGS

Hydraulic Pump Ring

Power Steering Pressure Plate

Transmission Governor Body

Universal Joint Yoke

Automatic Transmission Drum

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION

SAGINAW, MICHIGAN • DEPT. 10

83

Here's what Morse's entry into the "Timing"® Belt field means to you . . .

Nobody gives you a more impartial analysis of your power transmission problems than Morse, because . . . *only Morse* offers all four of these basic drives plus a complete line of power transmission products

Basic Drives: Roller Chain, Silent Chain, Hy-Vo® Drives, and "Timing"® Belt.

Chain: High-Endurance (H-E), 8-series (Super Strength), Double-Pitch, Conveyor, Implement, and Attachment; AL, BL, Cable Chain, and Roller-less Lift Chain; Industrial Standard and 3/16″ Silent Chain.

Stock Sprockets: Plain Bore, Finished Bore, Taper-Lock—also made to order.

"Timing" Belt Sprockets: Plain Bore, Taper-Lock, Q.D.—also made to order.

Couplings: Flexible Roller Chain Couplings, Flexible Silent Chain Couplings, Morflex Couplings, Morflex Radial Couplings, and Marine Couplings.

Driveshafts: Morflex and Radial Driveshafts.

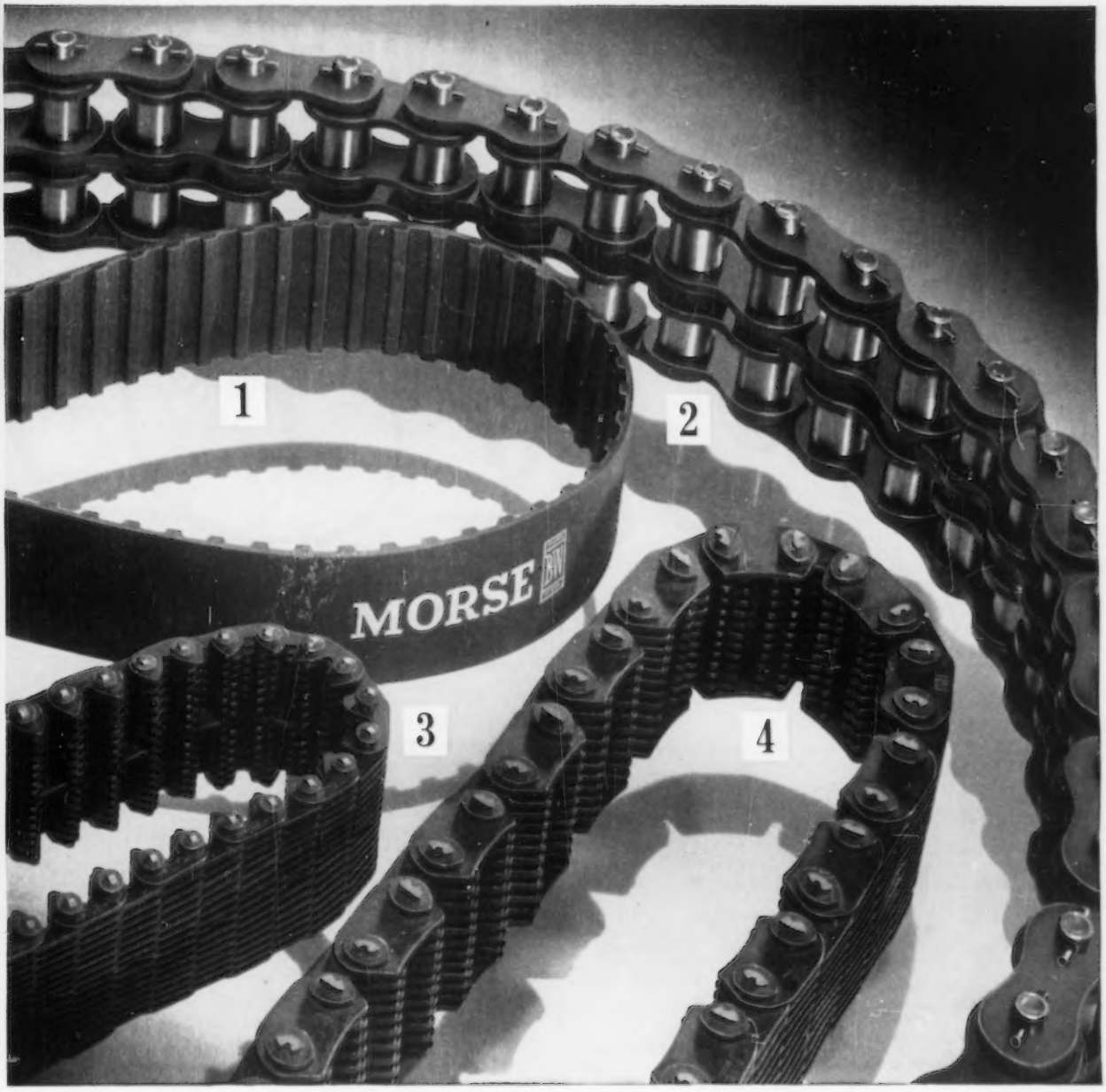
Clutches: Cam (Over-Running, Back-Stopping, Indexing); Pullmore; Over-Center, Centrifugal.

Speed Reducers: Eberhardt-Denver "RW" poweR-gear® Reducers; Gear Motors; "L" Worm Gear Reducers; "VX" and "DVX" Conveyor Drives; Miter Boxes; Helical Reducers.

Torque Limiters.

Look for your local Morse distributor in the Yellow Pages under "Power Transmission," or write:

MORSE CHAIN COMPANY, DEPT. 4-18, ITHACA, N.Y. Export Sales: Borg-Warner International, Chicago 3, Ill.



1. "Timing" Belt . . . for light weight and lubrication-free operation. Morse "Timing" Belts give positive, high-efficiency transmission from 0 to 16,000 FPM, 1/100 HP to 1,000 HP . . . provide slip- and stretch-proof service for life of drive.

2. Roller Chain . . . for low and medium speed applications. Precision-finished Morse Roller Chain is specially treated to withstand shock and fatigue, assure less maintenance, longer service life. Patented Spirol Pin Fastener construction.

3. Silent Chain . . . for smoother, quieter operation at higher speeds. In Morse Silent Chain the patented rocker joint operates with less friction and wear. It provides a cooler-running chain drive, with higher efficiency and longer service life.

4. Hy-Vo Drive . . . for extremely high speeds and horsepower. Exclusive with Morse, extra-tough Hy-Vo Drives transmit mile-a-minute speeds, and up to 5,000 hp loads; require minimum shaft space, usually eliminate outboard bearings.

IN POWER TRANSMISSION
THE TOUGH JOBS COME TO

MORSE

MORSE B-W BORG-WARNER

Plants in: Ithaca, N.Y., Detroit, Mich., Chicago, Ill., Denver, Colo., Simcoe, Ont.

*Trademark

IT'S HERE! AMERICA'S

pro-

NOW IN

The world's largest commercial plant to produce polypropylene is now on stream. Pro-fax, Hercules polypropylene, is the most significant new plastic to be developed in years. It has a lower specific gravity than any other plastic material commercially available. Pro-fax has higher tensile strength, hardness, heat resistance, stiffness, resilience and clarity, coupled with the inertness and water resistance typical of a hydrocarbon polymer. Pro-fax is exceptionally easy to mold, yielding parts with a hard, glossy surface available in a broad range of colors.

Among the other important properties of Pro-fax are excellent resistance to grease and oil, water, and many common acids; outstanding electrical properties; and higher impact strength. Altogether, Pro-fax combines more desirable properties than any other plastic now marketed.

There's sure to be a place for Pro-fax in your picture. For further information on properties and uses, call or write Hercules.

NOW THERE ARE TWO

Pro-fax is the Hercules trademark for polypropylene, a hydrocarbon polymer, based on propylene and a new Hercules process. Pro-fax will complement the usefulness of Hi-fax®, Hercules high-density polyethylene, greatly broadening the available markets for plastics, especially those now served by wood and metal.

Pro-fax is the second of many new polymers resulting from a Hercules research program designed to explore the chemical horizons opened by the development of organometallic catalysis systems. Others will follow as Hercules continues its leadership in the important field of polyolefin chemistry.

Cellulose Products Department

HERCULES POWDER COMPANY

900 Market Street, Wilmington 99, Delaware

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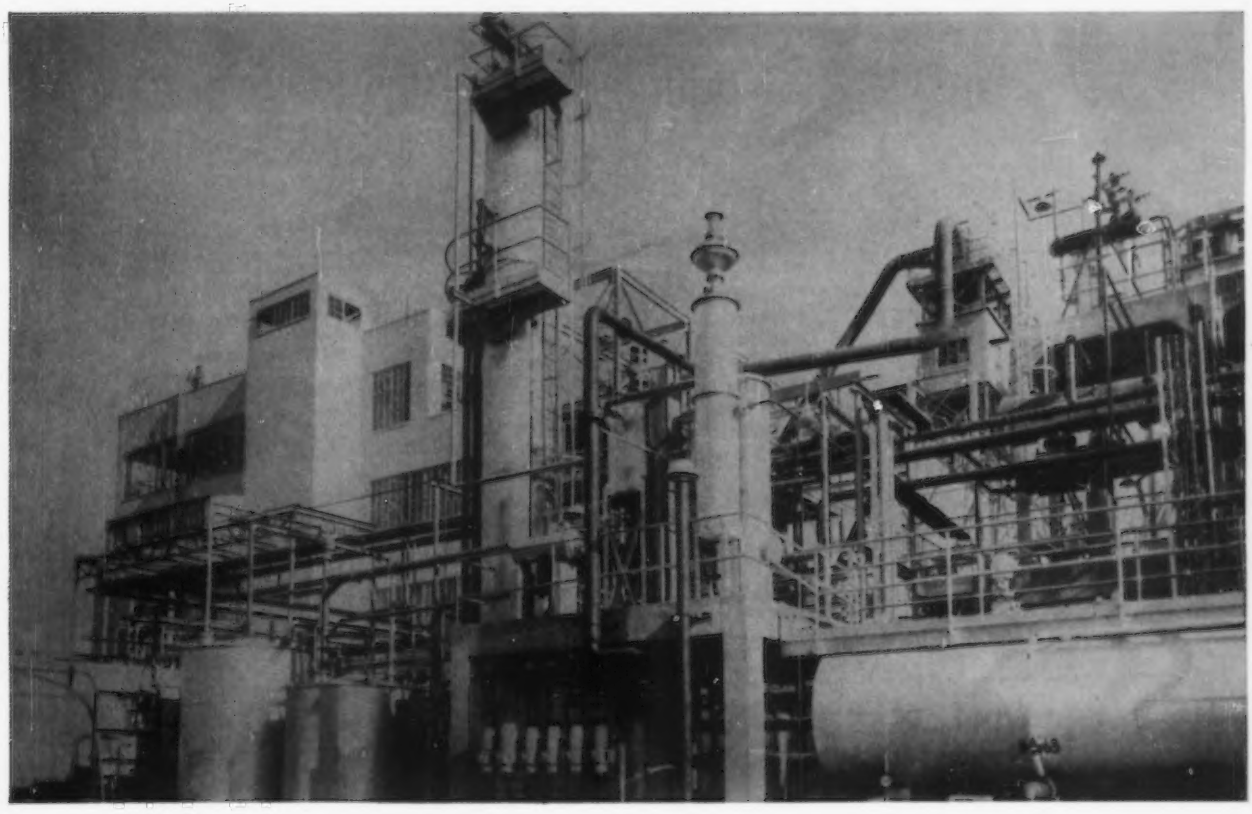

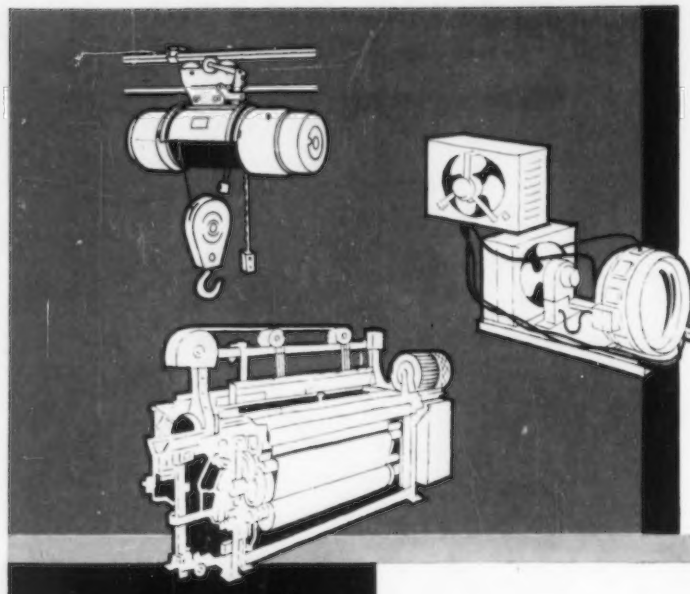

Whatever You Manufacture...

in all types of motor-driven equipment your 3-phase motors can be **protected against burnout —** with built-in KLIXON Protectors

Now your 3-phase motors can have the same engineered protection that motor manufacturers have supplied for years in single phase motors. That's because more and more motor manufacturers are making available 3-phase motors with built-in KLIXON Protectors.

You can get this protection against costly burnouts — protection that means maximum work output and minimum down time — in your 3-phase motors from fractionals up through 7½ HP (600V).

Get the details from your motor supplier . . . then specify and use motors with KLIXON Protectors. The additional cost is small, the savings worthwhile.

Built-in KLIXON Automatic and Manual Reset Protectors for single and 3-phase motors:

- Reduce production down time
- Eliminate motor burnouts
- Minimize motor repairs and replacements
- Assure maximum motor capacity
- Simplify motor controls

METALS & CONTROLS CORPORATION

Spencer Thermostat Division · 3801 Forest Street, Attleboro, Mass.

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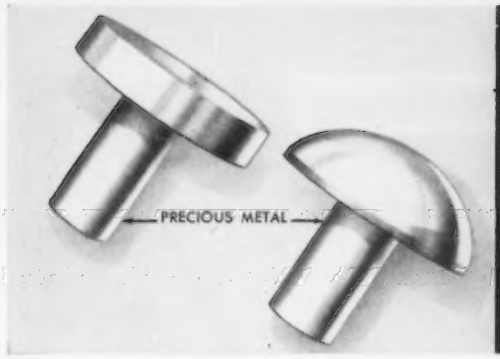


For Contacts Which Don't Exist Look to GENERAL PLATE

Paradoxical statement? Not at all — it's merely another way of saying that at G.P. you're not limited to yesterday's thinking in solving tomorrow's contact problems.

For beyond the tremendous variety of contacts already in production at G.P., are the know-how of G.P. engineers and the versatility of G.P. clad metals which combine to offer you better contact performance at lower cost.

Here are a few examples of new contact ideas which are now in commercial use at G.P.

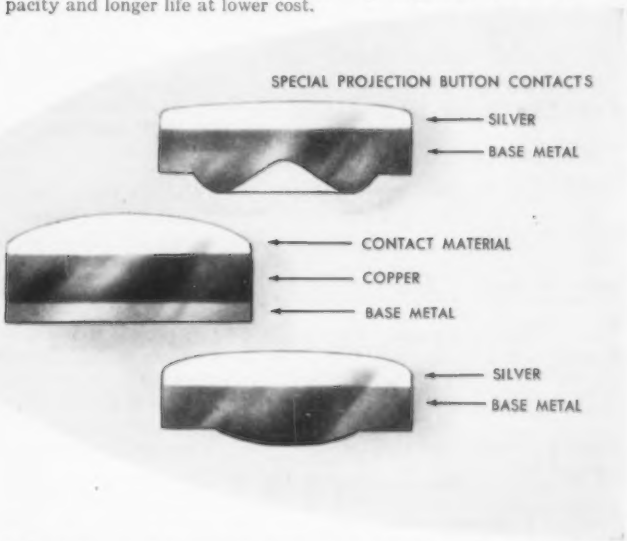
Clad Electrical Contact Tapes — designed for high speed mechanized assembly — ideal for miniaturization — give increased performance at reduced cost.

New Metal Bonding Processes — offer improved contact materials — include silver cadmium oxides, refractory metal mixtures and platinum group metals, as well as all regular silver materials.

New Clad Button Projection — designed and produced to meet your specific application requirements — facilitate easier welding, provide better conductivity.

Single and Double Inlay-Overlay-Top-Lay — made by G.P.'s new exclusive P.T. cladding process — achieves permanent bonding of preferred contact metals to practically any malleable base metal without intermediate bonding agents.

Trimetal Clad Projection Welding Contacts — a copper conductor between contact face and backing — provides higher specific heat with lower surface temperatures — gives greater contact capacity and longer life at lower cost.



With 41 years of General Plate metal cladding experience behind the emphasis now being put on G.P. electrical contacts, it will pay you to investigate. Technical data bulletins are available on request —just let us know what types of contacts you are interested in.

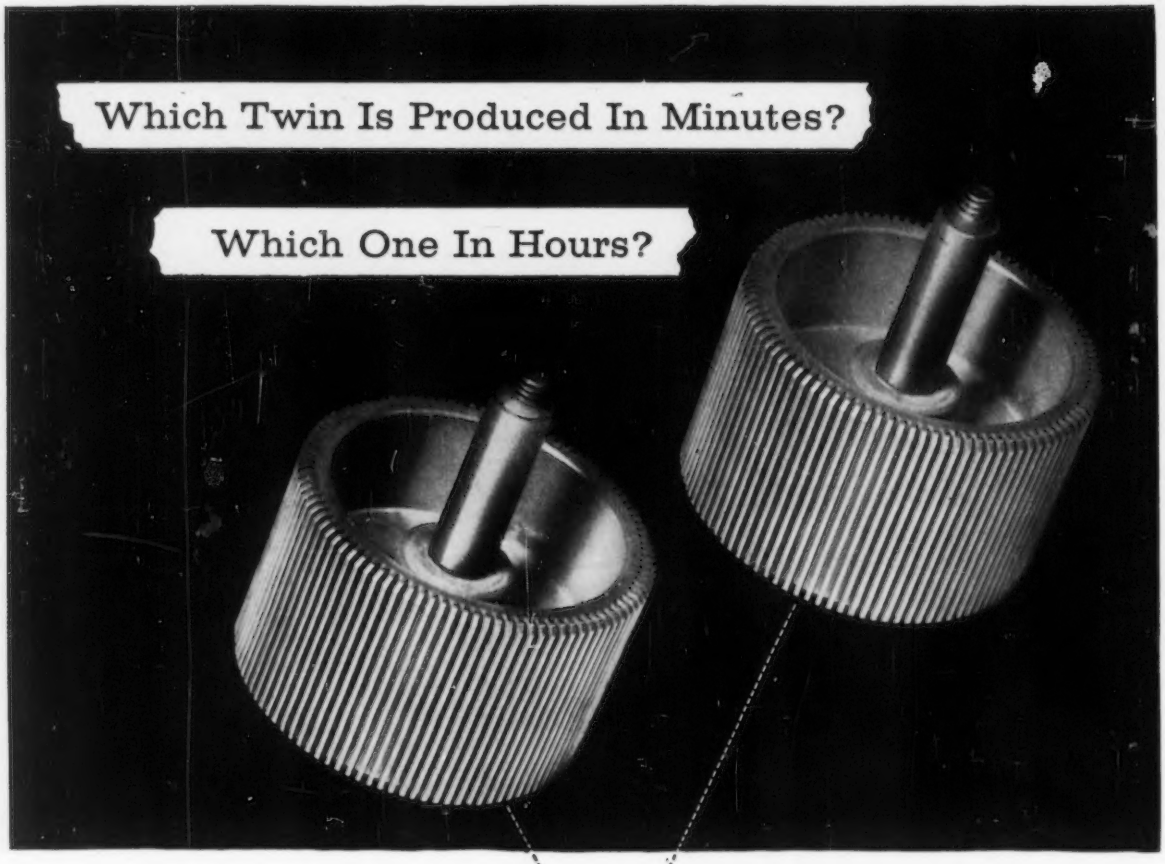
You can profit by using General Plate clad metals.

METALS & CONTROLS CORPORATION

General Plate Division

1001 Forest Street, Attleboro, Mass.

FIELD OFFICES: NEW YORK, CHICAGO, DETROIT, MILWAUKEE, LOS ANGELES.



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Fred B. Larsen • 6108 North 11 Avenue

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These parts are identical. One, however, is produced in minutes, the other in hours. Parker-engineered die casting makes the difference.

Formerly, this part (shown left above) was machined from the solid. The threaded steel shank was inserted in a separate operation. Numbers on the face (not shown) had to be stamped . . . still another operation. *Total production time per piece was measured in hours.*

Now, this same part, including the steel insert and the face numbers, is produced as a unit by Parker-engineered die casting. Trimming of gate and fins is the only secondary operation. *Total production time per piece is now measured in minutes.*

Here is just another example of the way Parker-engineered die castings save you money.

This skill and experience can solve problems—and save money—on *your* components parts. Just call the nearest Parker sales engineer or write the factory direct.

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Our "NE" valve—one of several Hannifin 4-way directional air control valves. Ask your Hannifin man when to use it.

Persistent research is bringing Hannifin valves to the most forward position in the field of pneumatic controls. These valves are opening up new areas of progress for sequential automatic production.

The Hannifin valves you buy today incorporate the very latest results of never-ending testing and development. Versatility of application and dependability of operation are winning them their position of leadership.

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For this complete catalog showing all the Hannifin directional air control valves, write to Hannifin Company, 525 South Wolf Road, Des Plaines, Illinois.

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now a colorful new name in aluminum!

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Announces Fabrication Facilities for

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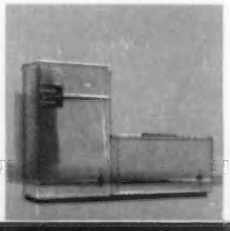
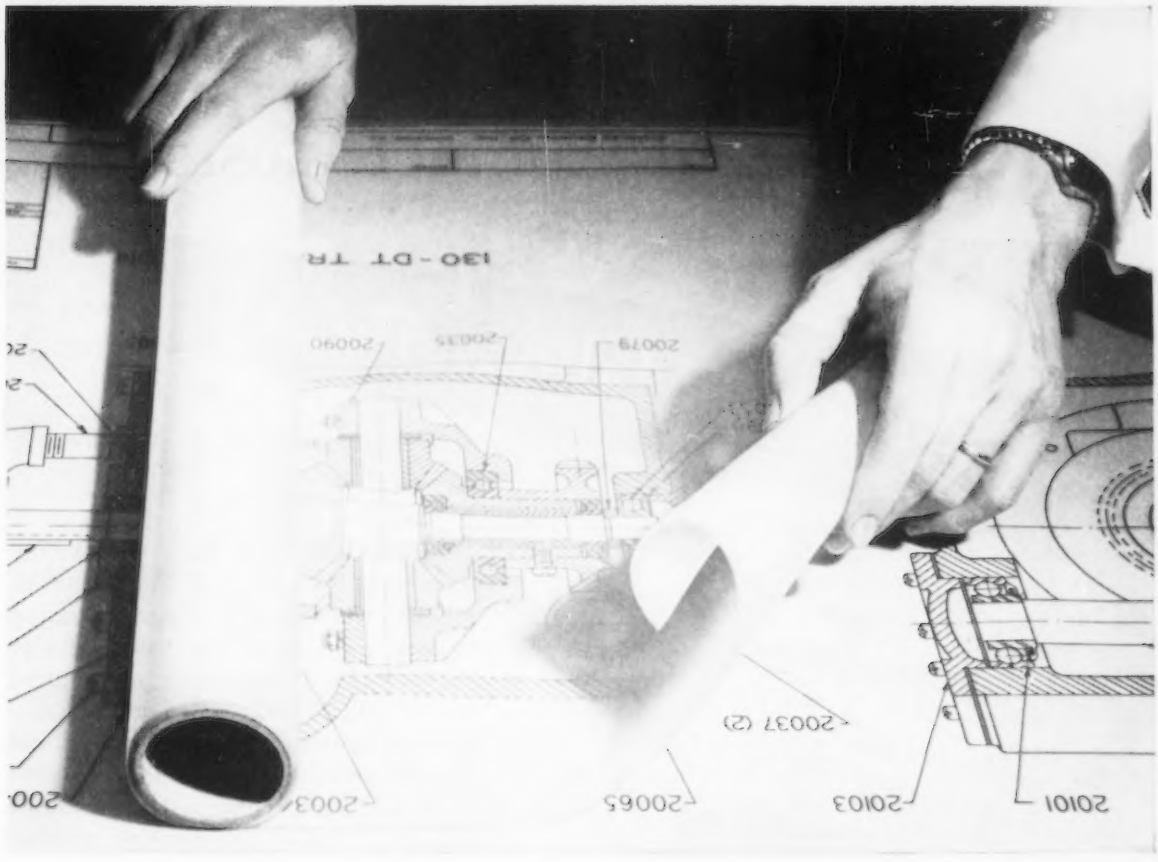
color-anodized parts and trim for automotive products and home appliances

Already producing! The industry's newest, most completely automated fabricating and anodizing facility! Firestone, long a leader in supplying steel parts and trim, now offers color-bright Fashionized aluminum. Aluminum shaped, textured and color-anodized for automobile and appliance brightwork. Aluminum tailored and tinted to the most exacting specifications. Aluminum mass-produced in sizes up to seven feet long. Aluminum delivered at new competitive schedules and costs that let you make the widest use of color trim. Firestone invites your inquiries—invites you to see its fashionizing facility, one of the largest in the world.

FIRESTONE STEEL PRODUCTS COMPANY, AKRON 1, OHIO



This is Firestone capacity. Each of the large anodizing racks shown here can process a full 120 square feet of aluminum at one time.



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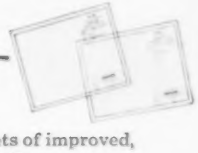

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MAYBE you have been overlooking some important savings that could be made in the electrical contacts you use in your products. Mallory has been helping design engineers uncover new sources of cost reduction through Contact Engineering Service. To give you some thought-starters on the subject, we've collected a number of actual case histories and put them in a convenient booklet.

In the reported savings on contacts for products ranging from magnetos to circuit breakers, we're sure you'll find ideas that are closely related to your own applications.

And we're sure, too, that we can do the same for you . . . by putting our long experience to work for you in engineering contacts, selecting the right Mallory alloy, and coordinating design of complete contact assemblies.

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DEVELOPMENTS TO WATCH...

Standards scheduled for review . . .

. . . and possibly revision by ASME committees this year include:

Spur-Gear Tooth Form (B6.1-1932)
Roundhead Bolts (B18.5-1952)
Lock Washers (B27.1-1950)
Plain Washers (B27.2-1953)
Gear Tolerances and Inspection (B6.6-1946)
Fine-pitch Straight Bevel Gears (B6.8-1950)

In addition, a major revision of *Drawings and Drafting Room Practice* is under way. Five of its 16 sections have just been published, and Section 6, Screw Threads, is scheduled to be published shortly. The remaining sections, the ASME says, should be ready by March or April.

Nearly a dozen brand-new standards are also under development; but only one, *National Miniature Screw Threads*, is scheduled for publication in the first half of this year.

Steel-reinforced plastics . . .

. . . aimed at solving two design problems, are being developed in Britain and Italy.

To permit use of plastics—particularly rigid polyvinyl chloride—at temperatures to 250 F, BX Plastics, Ltd. is reinforcing it with expanded metal mesh. Both mild steel and aluminum have been used.

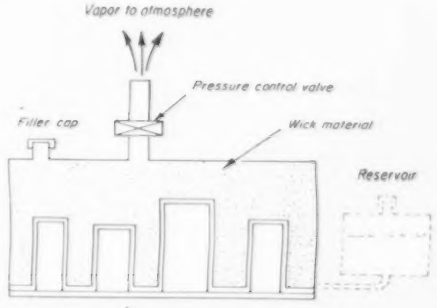
For greater mechanical strength—in machine housings, for instance—Mazzucchelli Culloide is laminating PVC to perforated metal sheeting. Here, the metal has an added advantage: By scraping away the plastic at selected points, the metal can be exposed and sections welded on as needed.

Treat polyethylene with chromic acid . . .

. . . to improve its bonding properties, Picatinny Arsenal recommends. Reporting on a long-term study of bonding this plastic, W. H. Schrader and M. J. Bodnar of Picatinny note that, by themselves, few commercial adhesives can meet Ordnance specifications, particularly since most depend on tackiness, rather than on chemical or mechanical action for their bonding effect. The chromic-acid treatment helps because it "alters the surface of the plastic so that good peel and shear strength are achieved."

Cooling systems that are simpler . . .

. . . lighter, smaller and cheaper are expected by Stewart-Warner South Wind Div. engineers to result from application of their "Liquid-Lock" evaporative cooling system. Using a glass-fiber wicking material, said to "retain 90% of its own volume in water," makes it possible to handle liquid coolants (Freon, water, polyalcohols) as if they were solids, yet "retain their characteristics as a heat sink." Already successfully applied to several aircraft cooling systems, including one for electron tubes (see diagram), the principle may also work with automotive and commercial air conditioning systems, and such operations as condensing liquids and removing water from gases.



To keep electron tubes cool . . .
surround them with wicking saturated with cooling liquid fed through cap or from reservoir

DEVELOPMENTS

TO WATCH...

Elastic paper . . .

. . . not creped, but with elasticity built right into the fiber construction, may be the next unusual new material for industry. West Virginia Pulp & Paper is working on it, using a process developed by Cluett-Peabody (not Sanforizing, for which C-P is so well known, but a new technique). Treatment is expected to increase strength and improve other properties of the paper as well as make it stretchable.

Uranium metal may be available in quantity . . .

. . . and at low cost (less than $20 a lb, anyway) as the atomic power program gets into high gear. This would be "waste" uranium, depleted in fissionable Uranium 235, but otherwise unchanged. Putting it to work, though, will be no simple problem. It can, of course, go back into such pre-atomic-age applications as chemical compound additives for glass and ceramics, and as a "getter" in gaseous discharge tubes.

The real challenge lies in putting uranium to work as a metal. It's not a very good one. It corrodes readily. It is hot short—and not too strong even at room temperature. And it is heavy. However, it is an excellent shield against gamma radiation (more than three times as effective as lead), and may well find a good many uses in this field.

Engineers interested in finding jobs for uranium will find no dearth of information on it. It is, perhaps, one of the most intensively studied of all materials. A good place to start is with the proceedings of last month's AIME symposium, now available in published form from the society, 29 W. 39th St., New York 18. Price—$5 to members, $7 to nonmembers. (143 pp, paperbound, 8½ x 11).

Smaller coils, for smaller electronic equipment . . .

. . . are being wound at Stanford Research Institute with the aid of the machine pictured below. Construction details are tied up by patent application, but SRI says the prototype makes it possible to wind coils whose outside dia equals dia of the hole through which they are wound, and even to wind through two adjacent holes in the same surface. Key to its performance: "The wire is made to pull itself through the hole," instead of being drawn or pushed. Next step—fully automatic operation.

—A.R.G.

Coil-winding machine . . .

paves the way for miniaturization. Samples of its tiny product are shown in right-hand photo.

Zinc Makers Planning Major R&D Program

NEW YORK—In the face of ever-stiffening competition from aluminum, plastics and stainless-steel makers, the zinc industry has decided to embark on an expensive as well as intensive research and development program early in 1958.

This was reported to PRODUCT ENGINEERING by John L. Kimberley, executive vice president and secretary of the American Zinc Institute, which is spearheading the effort. He said the R&D program "would many times multiply past and present projects undertaken by industry members."

While the zinc industry still considers its problems with the Tariff Commission of major importance, it recognizes that the "shooting star" ascendancy of the three main competitive materials contrasts sharply with zinc's "status quo".

ZINC BEING CROWDED

In particular, aluminum is crowding its way into autos, in many cases replacing zinc diecastings. (Kimberley expressed the opinion that such reports have to some extent been exaggerated.)

However, automotive representatives report that the "low-price three" clearly show the switch to aluminum. (Dec. 30, '57, p. 24) The 1958 models use less than 16 lb of zinc but more than 100 lb of aluminum per car. Of these 100 lb, aluminum diecastings account for 65. Not all of the increase in aluminum is at the expense of zinc; aluminum is sometimes used where zinc could not be.

Aluminum is shading zinc, for a number of reasons:

- Aluminum is a much better load-carrying material than zinc. And though the zinc industry is trying to improve the load-carrying characteristics of its metal, auto men feel that required changes would adversely affect other properties. One auto company points out that auto-application growth of aluminum is in structural parts, where finish is not a factor.
- Color anodizing of aluminum permits large variations of finishes. This, one auto maker feels, makes aluminum more desirable for panels, trim, and other applications where finish is important, especially so when the cost of plating zinc is considered.
- Resistance to corrosion is another reason why aluminum is replacing zinc. Aluminum is the choice for water pumps, where antifreeze is involved, for instance. Corrosion resistance is another reason why aluminum is making strides in exterior applications (grilles, light bezels, ornaments, panels).
- The feeling is that further reductions in zinc use are in prospect, and that some zinc will be used only for very small diecastings with intricate contours, which may not be producible in other metals.
- Zinc prices reflect the refiner's security in the zinc-bound galvanizing industry. Some call this security independence, some worse.
- The auto industry agrees that "the zinc industry has done nothing to increase its market in the automotive field."

Aluminum, in contrast, has been cultivating the automotive field aggressively, with auto companies ready to quote chapter and verse. They mention the big money aluminum is spending for research and development, often based on automotive needs and always available to car makers. They recall that aluminum makers act as though they have a community of interest with the auto makers, that they are always ready to act as consultants, and that they are especially careful not to recommend aluminum where they feel it would not make a good showing. And the automobile industry is convinced that aluminum is really trying to bring its price down.

WASHINGTON—A controversy over the matter of tariff protection for the lead and zinc producers has raged inside and outside of Congressional committee rooms, is now coming to a boil as members of the Tariff Commission decide what to do.

On the one hand, a group of American producers argue that drastic tariff action should be taken, that the commission should raise rates on lead and, or impose quotas. On the other, representatives of foreign zinc industries appeal that such action would not only hurt international relations between the US and others, but would also disrupt their economies.

Pres. Eisenhower during late August had promised that some action would be taken since the price of zinc was falling rapidly (about 3½¢ during 1957). However, his assurance may be tempered by the fact that in the countries affected—Canada, Mexico, Bolivia and Peru—mild recessions have occurred. The chief executive may now be reluctant to take any action that might aggravate already unpleasant conditions.

As the situation stands for US producers of zinc, their decision to go all-out with a program of research and development carries significance above and beyond the obvious need to "catch up" with aluminum. It means that US zinc makers just cannot rely on tariff hikes to improve their market position. They're joining the R&D bandwagon.

Engineer Shortage With Us Until 1960

NEW YORK—A shortage of college-trained engineers will persist until 1960 and possibly longer in the opinion of Deutch and Shea, Inc., technical-manpower consultants. They reach this conclusion in a study, "The Supply and Demand of Engineers—1950-1960." Their report is based on statistical evidence that the demand for engineers between 1950 and 1957 ran 46,000 a year while the supply increased by only 33,600. Supply in the next three years will increase to 41,500 they say, but demand is also increasing.

New Names, Faces and Offices in Nation's Capital

WASHINGTON — When the Russians sent Sputnik I zooming into space, they lifted the US a few feet skyward too. Their act touched off a series of fast-breaking moves by the US to clean house and recoup the number-one spot in the weapons race.

SPECIAL ASSISTANT FOR SCIENCE AND TECHNOLOGY

First major act was President Eisenhower's throwing of full White House support behind scientific developments. He named Dr. James R. Killian, President of MIT, special assistant for science and technology. It is an entirely new office. Dr. Killian immediately moved within a stone's throw from the White House and got down to revamping the nation's scientific efforts.

Right now, it is too early to say just what changes or new programs Killian will ask for. So far—and for some time to come—Killiam will be asking questions and listening to both government and non government scientists. He wants to become as fully informed as possible before he starts giving advice.

Killian is seeing no newsmen, has held no press conferences; and isn't likely to in the near future. His offices are staffed with four secretaries and one assistant—Henry Loomis, a former US Information Agency press officer.

Killian's shop looks like a bee hive from the ante-room. A PRODUCT ENGINEERING reporter saw continuously ringing telephones being fielded by the Secretaries. Killian for most of a 20-min period was talking with Deputy Defense Secretary Quarles. Nelson Rockefeller, Chairman of the President's Advisory Committee on Government Reorganization, was on another phone and was finally put through. In the meantime, plane reservations were being confirmed, dictated notes whipped into letters, names on lists checked and confirmed. This was just before Killian went to Paris with Eisenhower for the NATO meeting.

There's no doubt that Killian has rolled up his sleeves for all-out action. His official role is that of an advisor. But he is sure to exert a strong influence on military scientific programs, and will be a tough man for Pentagon brass to buck if their thinking doesn't mesh with his.

ADDITIONAL ADVISORS

To provide backstops for Dr. Killian, the President ordered the Science Advisory Committee transferred from the Office of Defense Mobilization and put directly on the White House roll of advisors. At the same time he added five scientists to the group, making a total of 17, plus five consultants. Pre-Sputnik, this group of top-level scientists met on government scientific programs about every two months. But immediately after the transfer to the White House, Killian met twice with them within two weeks.

The Pentagon is implementing Eisenhower's order to lump more power over missiles under one office, and to set up single managers for other new projects that come along. It is all geared to keep interservice rivalry from working to the detriment of the over-all defense effort.

The first step taken was the broadening of William M. Holaday's powers. He was special assistant for guided missiles to the Secretary of Defense. Now, Holaday's title has been changed to "Director of Guided Missiles," and his responsibilities have been extended to cover procurement of operational weapons and jurisdiction over all ballistic and guided missiles.

In the past, his control was limited to strategic missiles—long-range ballistic missiles and guided missiles, essentially pilotless bombers. His authority was limited to research, development, engineering and production, and did not cover procurement of operational weapons.

Holaday, however, isn't yet the "Missile Czar" that administration critics have demanded. He has no direct budgetary functions, for example, nor does he have the power to negotiate or cancel missile contracts. Holaday is presently under attack by senators who want a more powerful missile chief to take over all programs —one "who could make a decision, stick to it, and get it obeyed," as one senator put it.

Write It, Send It Charge It,

NEW YORK—Harried or hurried travelers passing through New York's West Side Air Terminal can for the first time send telegrams instantly and automatically on a "charge" or "collect" basis using "Autofax" facsimile transmitter equipment operated by Western Union. The push-button machien needs no coins or cash for operation. The sender writes his message on a form, marks it "charge" or "collect", pushes an actuating button, and drops the message in a slot. Transmission is automatic and charges are billed later to sender's address. Western Union says automatic telegram transmission on an I-trust-everybody basis has thus far resulted in little revenue loss.

Do-it-yourself telegram . . .

is on its way once it's dropped into slot. Western Union will trust senders, bill them later. Above test unit is first of nationwide network.

MIDWEST NOTES: Increase Heating Element Efficiency

ADRIAN, MICH.—Industrial heating elements with high efficiency and uniform heat transfer are produced by a new process shown here for the first time by H. W. Tuttle and Co. The production techniques can be applied to manufacture of household appliances, aircraft, automobiles, and all types of heaters.

Heating element is an 80/20 Nichrome wire covered with braided fiberglass and bent to the shape that gives the most uniform heat. Aluminum is then cast around this "core." Minimum temperature differential between resistance wire and aluminum heating surface is claimed as a result of the process. Uniform heat-transfer characteristics prevent hot spots and possible damage to materials being heated.

Advantages of new elements are low cost, low electrical leakage and ability to handle large currents. Leakage is on the order of ten microamps; standard electric heaters lead one milliamp or more. Obtainable temperatures are limited by the softening point of the aluminum casting; 900 F is considered maximum.

Though aluminum-cast heaters are ready for marketing, the inventor disclosed that other metals are being considered to produce higher temperatures for industrial applications. Research is underway for copper-base elements, and for the insertion of these elements in steel dies, especially in connection with plastic molding and extrusion presses.

The process was developed by Bahidj B. Sabouni, Director of Research for Soule Steel Co., San Francisco.

* * *

DETROIT—Styling will affect engineering redesign (see photo above). Because the low silhouette has cut under-hood space, a number of engine and other accessories are looking for room. The steering mechanism has been pushed forward in many 1958 autos. Now the power-steering pump is set up front too, and driven directly by engine crankshaft.

This Vickers development gives the pump a direct rather than transmitted, saves space for accessories.

Internal, regenerative supercharged system makes the pump capable of operating at speeds between 425 and 4600 rpm. Capacity at 1200 rpm is 6.9 gpm. A pressure relief valve limits max pressure to 1000 psi. . . . Colored tires are next. Automobile companies in Detroit have already received samples to give them a general idea of how they'll look. Color will be straight through the rubber.

BOAC Thrust Platforms Measure Up

LONDON — British Overseas Aircraft Corp. engineers at London Airport have developed portable ground-thrust platforms that can accurately measure aircraft thrust to ±0.3% directly through the plane's undercarriage. An airborne version based on the same principles, and tried out extensively on some military jets, revealed significant thrust ratings deviations.

Operating components include a thrust meter using a hydrostatic load cell that transmits pressure changes to a Bourbon tube and gage. The unit is similar to meters used extensively in aircraft weighing stations. A glycerine-base fluid, isolated in a cylinder by a neoprene diaphragm, is loaded by a ram that communicates the thrust. Ram and cylinder are made of a high-nickel alloy having a low-temperature expansion coefficient that makes the cell temperature independent over a useful working range.

Among the hydrostatic load cell's advantages, BOAC reports, are: absence of an external power supply; ability to hold calibration; great accuracy, and negligible temperature effects over a useful working range. The cell has an accuracy of ±5 lb in 14,000 lb. Readings taken at ranging points of thrust show no hysteresis.

The two platforms onto which the aircraft is wheeled are designed for single-wheel aircraft with a leg load of up to 40,000 lb. Each platform can accept up to 14,000 lb. thrust. Larger units can go up to 1 million lb. If the load cell is put in the platform to permit alignment with aircraft axle height, the platform is placed against an abutment.

Remote reading of the cell can be arranged through flexible capillary and detachable capillary couplings. Total thrust of any engine is sum of thrust readings from each platform.

In airborne application, the load cell is located in the engine trunnion mounting and is connected to a meter in the cockpit by a flexible capillary. Total weight of a single engine installation is only 8¼ lb. The meter has a three-finger dial giving a ¼-in. deflection for 5-lb load increments.

US to Spark Japan's Missile Research

TOKYO—Japan hopes to bolster its missile-research program next year with US technical aid, Juichi Tsushima, Director-General of the Defense Agency told a McGraw-Hill correspondent.

In particular, Japan needs help developing an air-to-air missile. Japan is also working on a surface-to-air missile.

Mr. Tsushima indicated Japan will decide in the next few months on a US plane to produce when its T-33 and F-86 programs are completed in 1959 and 1960. Four aircraft—the F-100, F-104, N-156 and F-11—are under consideration.

In his plea for US technical aid Mr. Tsushima said, "The less aid we get from America, the longer it will take to build our air force into an active defense organization and the longer you will have to remain in Japan to protect us."

Compressed Air Turns Copter Rotor

ROME—The Aviation Division of the Fiat Motor Company of Turin, Italy, has just announced a new all-purpose helicopter, the "7002", whose rotor is turned by compressed air generated by a rear-mounted 530 hp turbo-compressor.

The compressed air travels through a short feeder tube into the rotor housing, then piped through the interior of the rotor blade and expelled from jets at the rotor blade tips. The principle is similar to the one used in the French JIN.

The projected Fiat helicopter is a dual-control ship, designed to carry a pilot and six passengers or equivalent payload of 1,760 lbs at a maximum speed of 105 mph or a cruising speed of 85 mph.

It will weigh 3,080 lbs fully loaded or 1,320 lbs unloaded. It is to have a ceiling of approximately 10,200 ft and a range of 190 miles.

Feature of the "cold jet" machine is simplicity of construction, resulting from the absence of complicated transmission systems used in standard piston engines powered helicopters.

Fiat says that this will result in low maintenance costs, minimum operational and overhaul overhead as well as maximum functional efficiency.

Another Italian helicopter, prototype of which is under construction, is the Agusta-Zappata "AZ". This plane is powered by three turbine engines, one of which functions as a reserve to be used in cases of emergency when landing with an excess load, or on any occasion when extra power is needed.

The AZ has been partially financed by the Italian Air Force, and may receive additional funds from the Italian Navy which expects to use it in anti-submarine operations.

Engineers Protest Decreased Increases

SEATTLE, WASH.—Boeing Aircraft's decision to cut customary semiannual merit raises from 2% to ½ of 1% of its engineering payroll this Jan. 1 has stirred angry protests from the Seattle Professional Engineering Employees Association. SPEEA represents about 6200 nonsupervisory engineers employed by Boeing in the Seattle area.

The engineer's association contests the "opportunistic" decrease on three counts. They say (1) cuts have not been justified by work performance of employees. And, (2) business conditions have not been a factor. The SPEEA maintains the company has lost no important contracts so far and is likely to receive important new military and commercial orders in the near future. Finally, (3) the action, it is said, will have little effect on the company's competitive position, because savings will amount to less than 0.3% of 1% of the company payroll.

Engineering earnings in the Seattle area will now run about $1 million under their estimated 1958 total according to the SPEEA.

Boeing is withholding comment but is currently on a severe "austerity" program at the direction of the Air Force.

Announce Price List for Opel Caravan

FLINT, MICH.—Suggested port-of-entry list prices for the 1958 Opel *Caravan* have been set at $2,194.45 on the Atlantic and Gulf coasts and $2,376.59 on the Pacific. The prices were announced by Buick Div. of GM, which will handle American distribution of GM's German-made car.

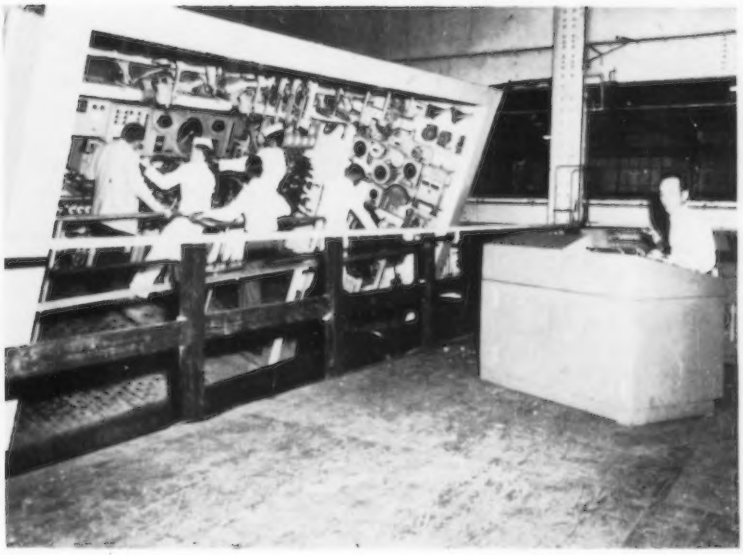
British Slash Funds for Rocket Range

LONDON, ENGLAND—Britain's proposed $56-million rocket-range project in the Hebrides has been slashed to $12 million, Defense Minister Duncan Sandys told the House of Commons this week.

Originally the facility was planned for air-to-air, surface-to-surface, and surface-to-air missiles. Under the revised plan it will fire in 1958 surface-to-surface missiles only.

Fence Deflects Jet Blasts . . .

. . . and has been approved for use with jet bombers, jet tankers and cargo aircraft on the basis of tests run by the Strategic Air Command at Castle Air Force Base, Calif. Until now, standard blast fences for Air Force have been of multivane, louvered design. Hurdles successfully passed by the Lynnco deflector include a 48,000-lb blast from four J-57 jet engines at full power. The manufacturer Lynn Engineering Co., San Francisco, claims the galvanized fence needs little maintenance and is air transportable. It will be licensed to other manufacturers if Defense Department demand requires it.



Tilt . . .
Rough weather, engine failure, and combat are simulated in this trainer for neophyte submariners at Navy's Groton, Conn., base. A roomful of computers, acting as engine room, diving planes, ballast system, and ocean, test trainees. Oscillograph at right charts their reaction to underwater problems and compares them with performance of experienced crew. Electric Boat Div., General Dynamics, makes the Simulator.

Envision Hawaii Atom Power Buildup

San Francisco—Hawaiian Electric Co. has taken the first steps toward possible erection of a nuclear power plant by filing a court condemnation suit to acquire a suitable 485-acre site. The locale is Kahe Valley, about 20 mi from Honolulu.

Hawaiian Electric President Leslie A. Hicks says the site can be used either for a conventional generating plant or a nuclear plant and will be needed for one or the other as Honolulu expands. Hicks reports that studies are now being made to determine if and when it would be economically feasible to build a nuclear plant. He estimates 1963 as the earliest date that a plant might be built.

The condemnation suit to acquire the land owned by the James Campbell Estate is described as a friendly one agreed on by both parties as the fairest way to establish value of the land. Standard Oil of Calif. will be building a $40-million oil refinery in the vicinity of 1958.

Nuclear plants may be economically feasible in Hawaii sooner than in any other part of America, according to Gwilyam A. Price, president of Westinghouse, who visited Hawaii last month. He cited lack of coal, gas and oil, the high demand for power, the necessary industrial plant, and the people and knowledge necessary to expand an economy on a base of atomic power.

COMING EVENTS

January 1958

6-8 . . . Fourth National Symposium on Reliability and Quality Control at the Hotel Statler, Washington, D. C. Sponsored by the AIEE, IRE, Electronic Industries Association, and the Electronics Div. of the American Society of Quality Control

22-24 . . . National Conference on Automation Systems, Arizona State College, Phoenix, Arizona. Sponsored by the Electronic Industries Association

28-31 . . . 14th Annual National Technical Conference of the Society of Plastics Engineers. Title: Progress Through Plastics Engineering." Sheraton-Cadillac Hotel, Detroit, Mich. For further information, contact C. H. Whitlock Associates, 21655 Coolidge H Hwy, Oak Park 37, Mich.

Engineers Air Views on Management

Ann Arbor, Mich.—Scientists and engineers in industry want personal recognition, difficult, but not impossible, assignments and freedom to solve research problems in their own fashion. They admit they are more individualistic than most others.

These are the principal findings of a U. of Michigan study resulting from two years of interviews with 400 scientists and engineers, their supervisors and executives in 10 companies. The firms—four chemical, two auto and auto parts, two electronic, and two public utility—all have large and long-established research divisions.

The professionals interviewed do not like to be treated as a group, the study showed. They like jobs suited to their special qualifications and want to use their talents to the maximum. Recognition of personal contributions is important to them, but the spread of team research is making this increasingly difficult.

Often the professionals take a skeptical attitude toward management practices affecting their work. They want to know the reasoning behind clerical, accounting, reporting procedures and the standards that apply in selecting or rejecting technical reports. They have an extreme distaste for routine tasks.

Standards a Trouble Source

Most serious unresolved conflict with management centers around the standards that apply to the work. The scientist admires technical excellence; management, fast, low-cost results.

Researchers and engineers have varying attitude toward supervision. The researcher counts on his supervisor to get support from management for facilities, personnel and supporting services. But he wants to be left alone on his job.

The engineer and those who apply research results count on their supervisors to inform them about what's going on, correct them when needed, and generally give more guidance than researchers get.

The report was prepared by the U-M Bureau of Industrial Relations.

READER TO EDITOR

WANTED—Troublemakers

To the Editor:

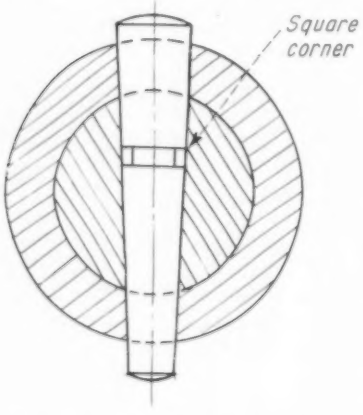
I have just read your editorial, "Troublemaker?" (Nov. 11, p. 83), and like what you have written—so much that I feel moved to immediately let you know my thoughts. We are going to cut this editorial out of the magazine and pass it to a number of our people here in our organization. Through the years, I have run into many "Troublemakers" such as you describe. I suspect that there is no question but that I was one myself; in fact, we are constantly seeking additional "Troublemakers" to add to our organization. —ROGER W. WALLACE

Plant Manager, John Oster Mfg. Co.

Another Way to Secure Taper Pins

To the Editor:

In the Nov. 11 issue (p. 122) you showed 17 ways to secure taper pins in place. The accompanying sketch, on which I have a patent pending,



shows another practical and convenient way which requires no special tools or staking and does not mar the outside of the parts.

Pins of this design can be used repeatedly, and if necessary, the holes can be reamed a little larger. When the pin is forced into the hole, the corner of the groove forces some of the wall metal into the groove, securing the pin in place. One or more annular grooves may be placed on the pin. —W. YATES FARNSWORTH

Redwood City, Calif.

Complete PE File Available

To the Editor:

My husband died 18 months ago leaving a complete file of PRODUCT ENGINEERING dating from 1932. Would you be good enough to tell us where these could be best used.

—MRS. EAKIN L. WHELESS

Shreveport, La.

• *Any reader interested in this complete library may contact Mrs. Wheless at 829 Oneonta St., Shreveport, La.—Ed.*

Kudo for Perspectives

To the Editor:

Your "Perspectives" in the Nov. 11 issue, (p. 79) will be hailed by all who are trying to help engineers write better. And, of course, will help all engineers, designers, and other PRODUCT ENGINEERING readers who heed your advice. It is worth repeating over and over.

—JOHN L. KENT, *President Technical Writing Improvement Society* *Pasadena, Calif.*

Capital Cat

To the Editor:

Our attention has been invited to a picture and caption appearing on page 71 of your Oct. 28 issue. The caption on picture 5 reads "Aluminum pistons . . . for caterpillar tractor carries cast-in-place insert . . ."

This is to inform you that "Caterpillar" and "Cat" are trademarks registered for our exclusive use in describing products of our manufacture. You undoubtedly were referring to our engines, and we have only one suggestion—we would appreciate your using a capital "C" when mentioning "Caterpillar" or "Cat."

—BURT POWELL

Advertising Manager

Caterpillar Tractor Co., Peoria, Ill.

What Is Truth?

To the Editor:

The last paragraph of your editorial, "Don't Tense" (Nov. 25, p. 71) deals with truthfulness. "Truth," used as a noun, has no meaning. "Truthfulness" as a noun implies that something has the property of being truthful. This is brought to mind by a discussion I had with a great man less than a year ago. He had evolved the following concept of truthfulness. The speech of a truthful man coincides exactly with what he knows and believes, no more, no less. The truthful man does not tell half-truths, nor does he embroider on the truth.

A poor set of values for truthfulness and intellectual honesty allows a man to speak in ignorance or, if informed on his subject, to misdirect his communications with others. You keep PE remarkably free from articles which rehash the articles which rehash. Congratulations and thanks.

—J. P. LAIRD

E. I. du Pont de Nemours & Co.

Newark, Del.

The Men Who Made the Models

To the Editor:

In analyzing your Oct. 28 cover, we noticed that the only units not fabricated by us were the Northrop F89D Scorpion kit, Douglas CD8 Transport, Boeing 707 Stratoliner and the Douglas A4D Sky Hawk. We produced the balance of the miniatures shown, for the respective aircraft companies in the US. You can naturally assume that we here at Topping Models were quite pleased to be so honored. However, this pleasure was tempered to some degree because no mention was made in your short article on page 5 as to the manufacturer. Would it be possible for us to receive some credit as being the designer of 11 of the 15 planes shown? —E. W. TOPPING

Topping, Inc.

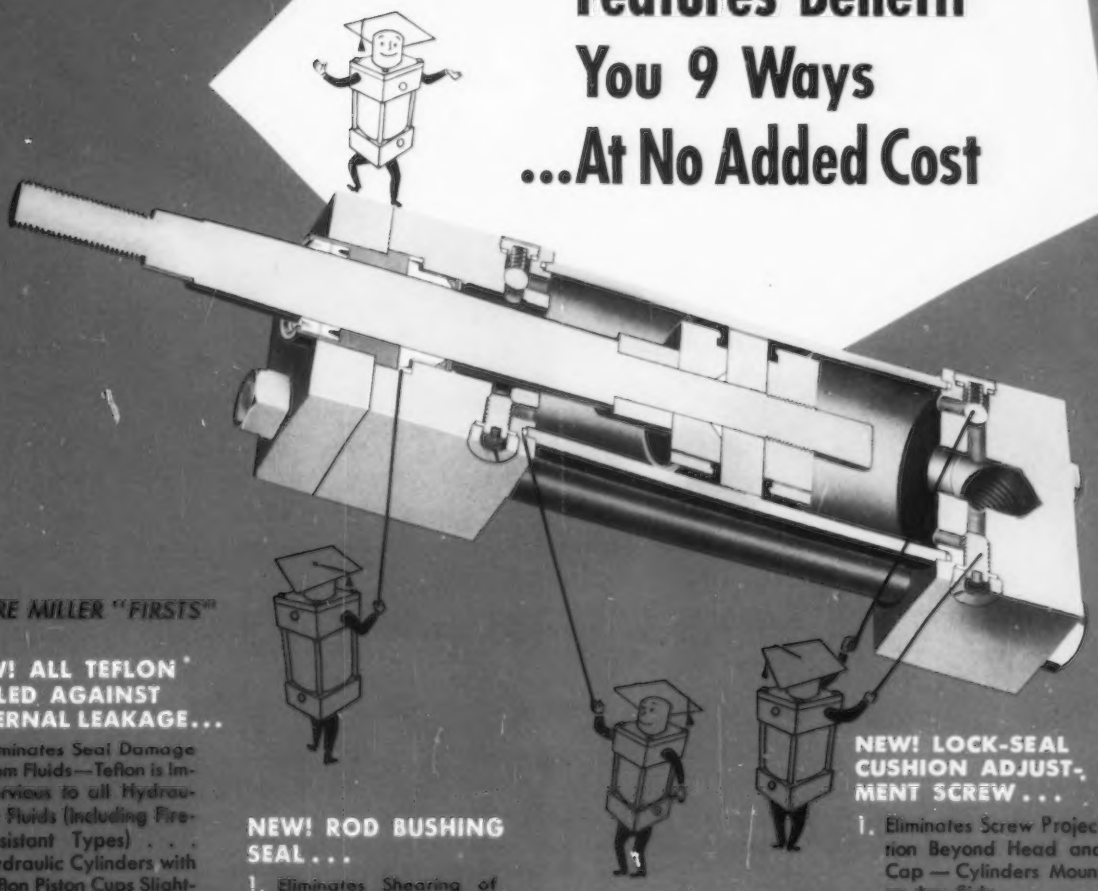
• *For those interested in learning more about these models, made for makers of boats and industrial equipment as well as planes, write to: Topping Models, 517 First National Tower, Akron 8, Ohio. —Ed.*

Our Error

Inadvertently, the author's name was omitted from the lead article in the latest Design Edition. As properly shown on the Contents page, L. A. Yerkovich, research metallurgist at Cornell Aeronautical Lab., Buffalo, contributed the stimulating article, "Watch Out for Compression Loads," Dec. 9, p. 72—*Ed.*

Miller®

4 New Hydraulic Cylinder Features Benefit You 9 Ways ...At No Added Cost



MORE MILLER "FIRSTS"

NEW! ALL TEFLON* SEALED AGAINST EXTERNAL LEAKAGE...

1. Eliminates Seal Damage from Fluids—Teflon is impervious to all Hydraulic Fluids (including Fire-Resistant Types) . . . Hydraulic Cylinders with Teflon Piston Cups Slightly Higher.
2. Eliminates Seal Damage from High Temperatures —Teflon Sealed Cylinders Operate At —100° F. to 500° F.

NEW! ROD BUSHING SEAL . . .

1. Eliminates Shearing of "O" Ring in Re-Assembly
2. Eliminates Extrusion of "O" Ring at Extreme Pressures.

NEW! SHEF SEAL AT TUBING ENDS . . .

1. Eliminates Shearing of "O" Ring in Re-Assembly
2. Eliminates Extrusion of "O" Ring at *ANY* Pressure—Teflon Sealing Ring is Backed Up by Zero Clearance Metal Shoulder.

NEW! LOCK-SEAL CUSHION ADJUSTMENT SCREW . . .

1. Eliminates Screw Projection Beyond Head and Cap — Cylinders Mount on Any Side.
2. Eliminates Manual Sealing and Locking After Flow Adjustment—Teflon Seal is Self Regulating and Self Locking.
3. Eliminates Accessibility Problems—Cushion Screw Interchangeable with Ball Check Position—Adjustable Through Small Wrench Hole Drilled in Interfering Machinery.

*du Pont trademark for its tetrafluoroethylene resin.

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Turn Page For Cross Section Of SHEF SEAL

S SHEAR PROOF
H HEAT PROOF
E EXTRUSION PROOF
F FLUID PROOF
SEAL

Teflon Pressure Energized

Hydraulic Cylinder Tubing End Seal

PAT. APPLIED FOR

OTHER MILLER QUALITY FEATURES

- Case-Hardened Chrome Plated Piston Rod
- Rust Resistant Surfaces
- Teflon Oil and Dirt Wipers
- Interchangeable Square Design

MILLER FLUID POWER

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2002-04 N. Hawthorne Ave., Melrose Park, Ill.

AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

Miller®

Announces a New Space and Price Saving Hydraulic Cylinder Line

SAVE UP TO 76% OF COST

Heavy Duty Model LH—Same Size As Ordinary Gasket Type Square Design Low Pressure Cylinders			
BORE	NORMAL RATINGS	NON-SHOCK INTERMITTENT RATINGS	YOU SAVE THIS % IN PRICE OVER STANDARD 2000-3000 PSI CYLINDERS
1½"	1500 PSI	2500 PSI	27%
2	1500	2500	27%
2½	1000	1500	28%
3¼	1500	2500	32%
4	1000	1500	35%
5	800	1200	37%
6	800	1200	43%
8	500	800	50%
10	500	800	71%
12	500	800	76%
14	500	800	*Not Available in 2000-3000 PSI*

MORE MILLER "FIRSTS"

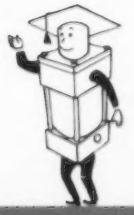
Miller®

Announces 50% More Power Per Cylinder Dollar

with Extra Heavy Duty

3000-5000 PSI MODEL H HYDRAULIC CYLINDERS

Same Price and Mounting Dimensions as Miller 2000-3000 PSI Hydraulic Cylinders.



BOTH LINES MADE POSSIBLE BY SHEF SEAL

Write For New Hydraulic Cylinder Bulletin

MORE MILLER "FIRSTS"

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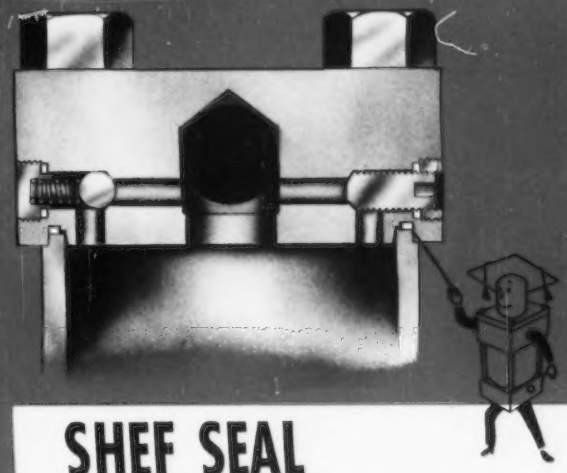
COUNTERBALANCE CYLINDERS • BOOSTERS

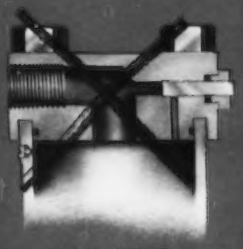
OTHER MILLER QUALITY FEATURES

- All Teflon Sealed Against External Leakage—Teflon Cups Extra
- Case-Hardened Chrome Plated Piston Rod
- Shear Proof Rod Bushing Seal
- Ball Check Interchangeable with Self Sealing and Locking Cushion Adjustment
- Rust Resistant Surfaces
- Teflon Oil and Dirt Wipers

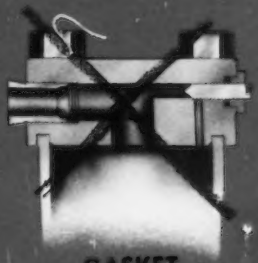
Miller

SHEF SEAL Obsoletes All Other Hydraulic Cylinder End Seals . . . *at no added cost*





"O" RING



GASKET

SHEF SEAL

HAS EVERY ADVANTAGE

NONE OF THE DISADVANTAGES OF OBSOLETED "0" RING AND GASKET CONSTRUCTION

Shearproof! Location of Teflon sealing ring eliminates blind assembly, makes shearing impossible. One sealing ring cross section dimension for all cylinder sizes—supplied on convenient spools.

Blind "0" ring assembly can shear rings and create difficult servicing problems. Large inventory required for servicing varying cylinder bores. Gasket construction unpredictable—outlawed by J. I. C. eight years ago.

Heatproof! Teflon sealing ring provides leakproof sealing at temperatures from —100° F. to plus 500° F.

Gaskets and "0" rings require extra inventories of special synthetic compounds to meet various operating temperatures.

Extrusionproof! Zero metal-to-metal clearance at all pressures provides perfect seal backup. Sealing ring cannot extrude at any pressure, permitting higher operating pressure ranges.

Gaskets can leak and blow even at low temperatures. "0" ring extrusion is one of the most prevalent causes of hydraulic cylinder repairs and maintenance.

Fluidproof! Teflon sealing ring seals perfectly and permanently against all known hydraulic fluids including fire-resistant types.

"0" rings must be specially compounded for use with different hydraulic fluids. This means large, expensive inventories.

OTHER DESIRABLE FEATURES

SHEF SEAL is a pressure energized seal—its sealing effectiveness increases with pressure. It allows air bleeds in head and cap for remote or automatic bleeding. Its zero metal backup clearance eliminates dangerous leaks and spurts of fluid due to seal failure. Head and cap axial movement does not destroy seal.

ELIMINATE THESE DISADVANTAGES

"0" ring construction requires location of air bleeds in cylinder tubing. Failure of gaskets and "0" rings causes leaks and spurts of fluid that create dangerous fire and safety hazards.

SHEF SEAL—*Another Miller "First"*

S SHEAR PROOF
H HEAT PROOF
E EXTRUSION PROOF
F FLUID PROOF
SEAL
Teflon Pressure Energized
Hydraulic Cylinder Tubing End Seal
PAT. APPLIED FOR

OTHER MILLER QUALITY FEATURES

- All Teflon Sealed Against External Leakage—Teflon Cups Extra
- Case-Hardened Chrome Plated Piston Rod
- Shear Proof Rod Bushing Seal
- Ball Check Interchangeable with Self Sealing and Locking Cushion Adjustment
- Rust Resistant Surfaces
- Teflon Oil and Dirt Wipers

MILLER FLUID POWER

DIVISION OF FLICK-REEDY CORPORATION

Turn Page For More About MILLER

AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

All Teflon Sealed —Perfect Sealing for Hydraulic Cylinders

HAS EVERY ADVANTAGE...

Teflon—As Static and Dynamic Seals

1. Impervious to Every Hydraulic Fluid Including Fire-Resistant Types.
2. Seals Perfectly in Cylinders at Temperatures from —100° F. to 500° F.
3. Can Be Molded Into Shapes That Have Zero Leakage—Hold Pressure Indefinitely.
4. With Proper Design of External Seal Cavities, Teflon Can Be Included *Without* Increasing Prices. Miller Provides Teflon for all External Seals at Prices Competitive with Ordinary Cylinders. Leather Internal Piston Cups are Standard (Teflon Cups Extra).

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•du Pont trademark for its tetrafluoroethylene resin.

When you buy Miller
You buy extra years
of worry-free
Cylinder performance
...at competitive prices

NONE OF THESE DISADVANTAGES

Synthetic Rubber— As Static and Dynamic Seals

1. Unsatisfactory Except When Used With A Limited Range of Hydraulic Fluids.
2. Even Uncontrollable Changes in Fluid Additives Often Destroy Seal.
3. Specific Compounds Needed for Compatibility with Specific Fluids Normally Used Today.
4. Normal Temperature Range Limited to 0° F. to 130° F. Slightly Reduced Life When Operated at 130° F. to 150° F. Greatly Reduced Life at 150° F. to 250° F.
5. External Leakage Causes Fire and Safety Hazards When Temperature or Fluid Destroys Seals.
6. "U" Type Seals Without Mechanical Retainer at Mid-Section Frequently "Roll" and Lose All Sealing Ability.

Resin Impregnated Leather— As Dynamic Seals Only

1. Is Compatible with Many—But Not All—Hydraulic Fluids and Additives Including a few Fire-Resistant Types.
2. Normal Temperature Range Limited to —60° F. to 130° F. Slightly Reduced Life When Operated at 130° F. to 150° F. Substantially Reduced Life at 150° F. to 250° F.
3. External Leakage Causes Fire and Safety Hazards When Temperature or Fluid Destroys Seals.

Miller Uses Leather Piston Cup Seals for Internal Sealing... Standard Price (Teflon Cups Extra).

Piston Rings— As Dynamic Internal Seals

1. Most Piston Rings Allow Some Leakage.
2. Allow "Slip" or "Drift" of Piston Due To Leakage—Unsatisfactory for Many Applications.
3. Allow Varying Feed Rates Due To Leakage Because Of Viscosity Change During Startup—Unsatisfactory for Most Multiple and Automated Operations.
4. Allow Some Pressure Loss.
5. Chips and Dirt Enter Space Between Piston and Tube Causing Scoring —Especially During Startup.

Write For New Hydraulic Cylinder Bulletin

MILLER FLUID POWER
DIVISION OF FLICK-REEDY CORPORATION
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OTHER MILLER QUALITY FEATURES

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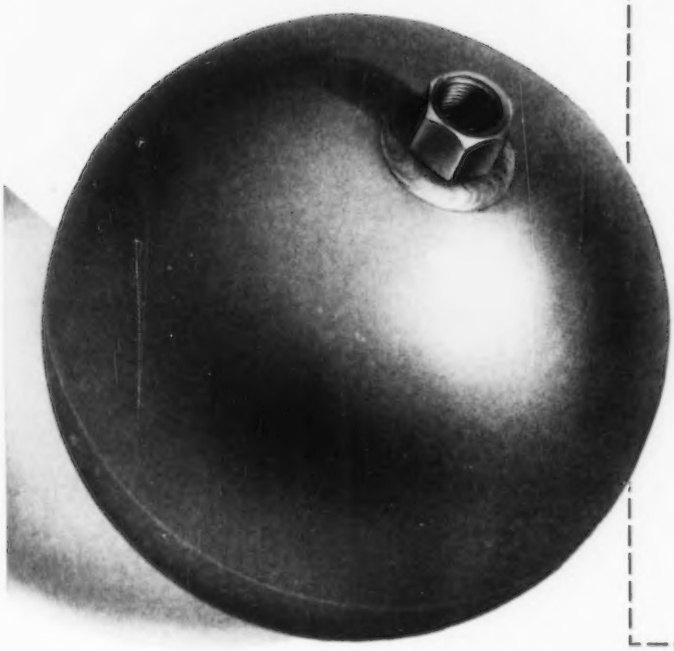
- Shear Proof Rod Bushing Seal
- Ball Check Interchangeable with Self Sealing and Locking Cushion Adjustment
- Rust Resistant Surfaces
- Teflon Oil and Dirt Wipers

need floats?



Name the way you want them!

MATERIAL_____
SHAPE_____
SIZE_____
PRESSURE_____
QUANTITY_____
MORE INFO_____

*Your Name*_____
*Title*_____
*Company*_____
*Address*_____

See below for details
Fill in blanks, tear out, and mail to:
W. H. NICHOLSON and COMPANY
Wilkes-Barre, Pa.

Nicholson can deliver precision welded floats —made to your specifications—to fit your production schedule. Use the above form to tell us how you want them.

Here are the standard specs:

- **MATERIAL**—steel floats with chromium, cadmium or copper plating—with sandblast or pickled finish . . . stainless steel and Monel floats—rough-buffed, polished or with welds ground smooth and highly finished.
- **SHAPE**—spherical, elliptical, cylindrical.
- **SIZE**—from 2 inches to 14 inches diameter.
- **PRESSURE**—from vacuum to 4800 lbs.
- **QUANTITY**—as many as you need.

These high tensile strength floats have exceptional resistance to pressure and corrosion. Float halves are die-formed, with inward rolled edges—not spun, laminated or electrodeposited.

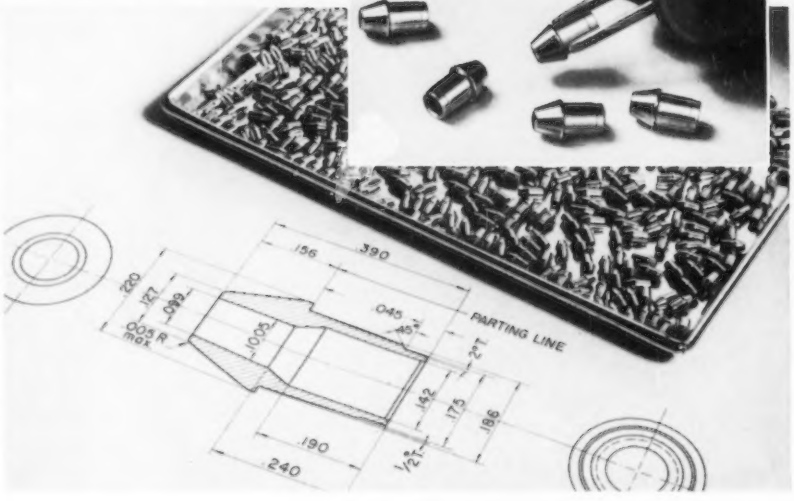
Today, thousands of Nicholson floats are in service—most as buoyancy mediums . . . many as fluid chambers and pressure vessels. Write for details about the full Nicholson line.

W. H. NICHOLSON AND COMPANY, 12 OREGON ST., WILKES-BARRE, PA., *Sales and Engineering offices in 98 principal cities.*

NICHOLSON
of Wilkes-Barre

GRC DIE CASTING TECHNIQUES CUT COST ON TINY BUSHING TO $2.00/M

Simple part less than ½" long mass produced in zinc alloy in a single automatic operation



This tiny bushing is used in a ball point pen. Overall it is .390" long and .220" wide. It was formerly made on screw machines, but Gries Reproducer Corporation was able to die cast it in zinc alloy in a single automatic operation reducing the cost to little more than $2.00 per thousand. In addition to lowering costs substantially, GRC exclusive methods guaranteed the perfect uniformity of each individual piece in the million part run. The manufacturer also took advantage of GRC's service to their customers on secondary operations and had the part nickel plated.

Not only in this case, but in many others in which both commonplace and extremely intricate parts were involved, Gries unique patented die casting techniques have made possible exceptional savings and broad flexibility in design.

A fact-filled die casting bulletin, yours for the asking, is put out by GRC explaining their exclusive methods and showing how Gries has helped solve problems on parts "no bigger than your thumbnail" (maximum is 1¾" long, ½" oz., no minimum).

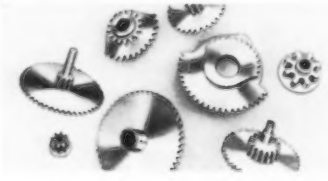
Special Design Wing Nuts to Meet Unusual Needs Now Stocked by GRC

GRC lists in a recently issued catalog sheet the complete specifications on their wide assortment of special design Wing Nuts—High Wing, Round Wing, Low Wing, Low Low Wing and Special Low Wing styles—in a wide range of blank and thread sizes. Also cataloged are Senior, Junior and Economy Type Wing Nuts with plain or serrated bases. In all, more than 100 separate types are listed.

Fastenings are die cast in zinc alloy in quantity to assure uniformity and keep prices low thru GRC's unique techniques.

This new catalog sheet and catalog sheets on their round head thumb and cap nuts, wing and round head thumb screws, rivets, etc., available direct from Gries Reproducer Corp.

Small Gears, Pinions, Hubs, Shafts, etc., Available Individually and in Various Combinations from Stock Dies



GRC issues a catalog sheet listing more than 40 individual items and stock sizes of gears, pinions, hubs, shafts, etc., available individually and in various combinations. All items listed are automatically die cast of zinc alloy . . . all combinations are made in one piece. Holes, shafts, spacers, shoulders, etc., are to order and no extra tool charge is made on quantities.

Gries Reproducer Corp. will also die cast in zinc alloy on special order unusual shapes, meet extra precise requirements, in quantities from 50,000 to millions. Prompt quotations on special orders will be made upon receipt of blueprints or specifications. Stock catalog sheet will be sent on request.

Helpful New GRC Kit is Big Aid to Product Designers

Gries Reproducer Corp. has developed a new kit for designers and production men. Its purpose is to acquaint them with the almost unlimited scope in small parts design and the tremendous savings which GRC exclusive methods make possible.

The kit concentrates in one unit informative data on the extent and flexibility of these unique processes; including one-piece zinc alloy die castings, "intercast" movable, multiple element units, nylon and other plastic moldings, standard components: fastenings (wing and round-head thumb nuts and screws, cap nuts, rivets, etc.), gears and pinions, toy parts, miniature novelties, nylon screws and coil bobbins.

You can obtain this new GRC Product Designer's Kit by writing direct to Gries Reproducer Corp.

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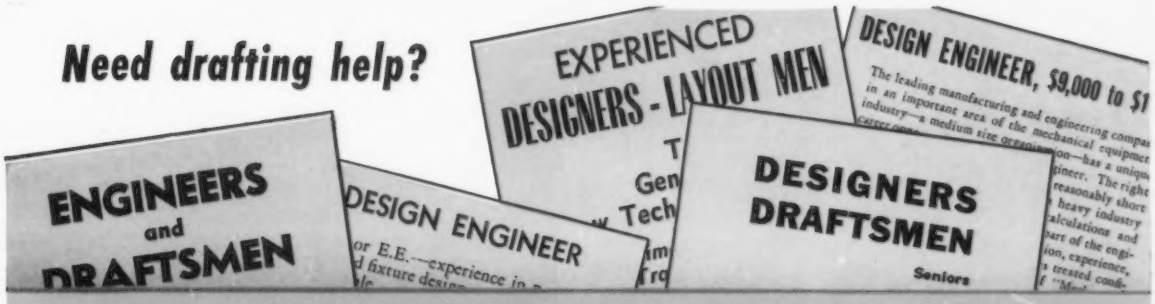

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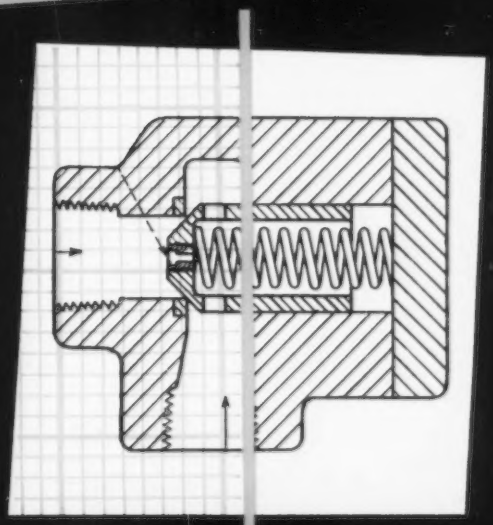

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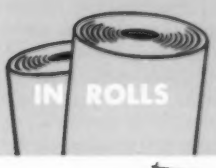

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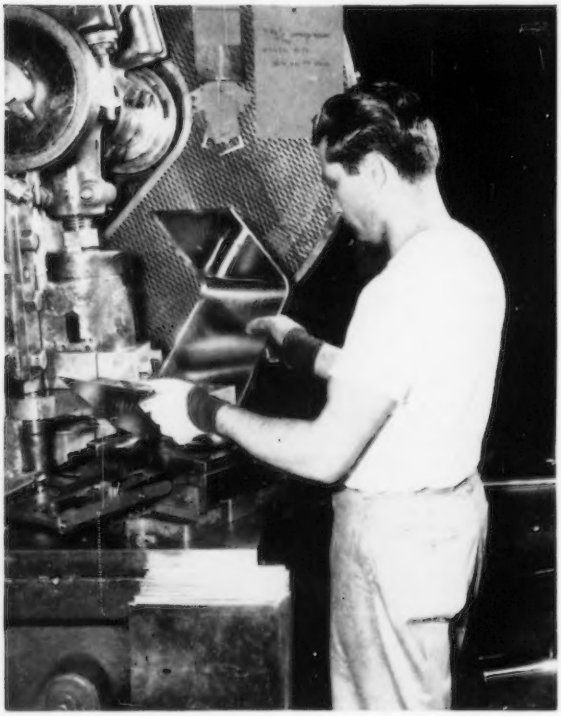
Production Takes A Short-Cut

With Pre-Plated NICKELOID METALS

Sheet of Nickeloid chrome-steel that will be used for breadbox is blanked, with punch-out perforations for ventilation and indented shelf supports. Uniform pre-plated finish reduces rejects.

Edges of Nickeloid chrome-steel sheet are turned up ½" in forming press. Nickeloid is easily worked with standard methods.

Breadbox body frame is spot welded to the preformed bottom and back pieces, with no visible oxidation. Parts then move to assembly.



Two bends are made on press to give the breadbox its rectangular shape. Operation causes no marring of surface or dulling of finish.

No Cleaning or Post-Plating — Easily Worked With Standard Production Methods

No cleaning solutions, plating tanks or polishing wheels on the production line at Lincoln Metal Products Co., Brooklyn, N.Y., manufacturer of fine pantryware. Lincoln eliminates these costly intermediate steps by using Nickeloid pre-plated chrome-steel and copper-steel. These versatile design materials speed trouble-free production, reduce rejects, prolong tool life. They are readily worked with standard production methods, as shown here. Parts move from fabrication — to assembly — to packing, with no dulling or marring of the pre-plated finish, since Mar-Not protective covering is used. No cleaning, plating, polishing is needed. Nickeloid Metals are available in pre-plated finishes of chrome, nickel, copper or brass on steel, zinc, copper, brass and aluminum. Sheets, strips, coils — a wide range of finishes and patterns.

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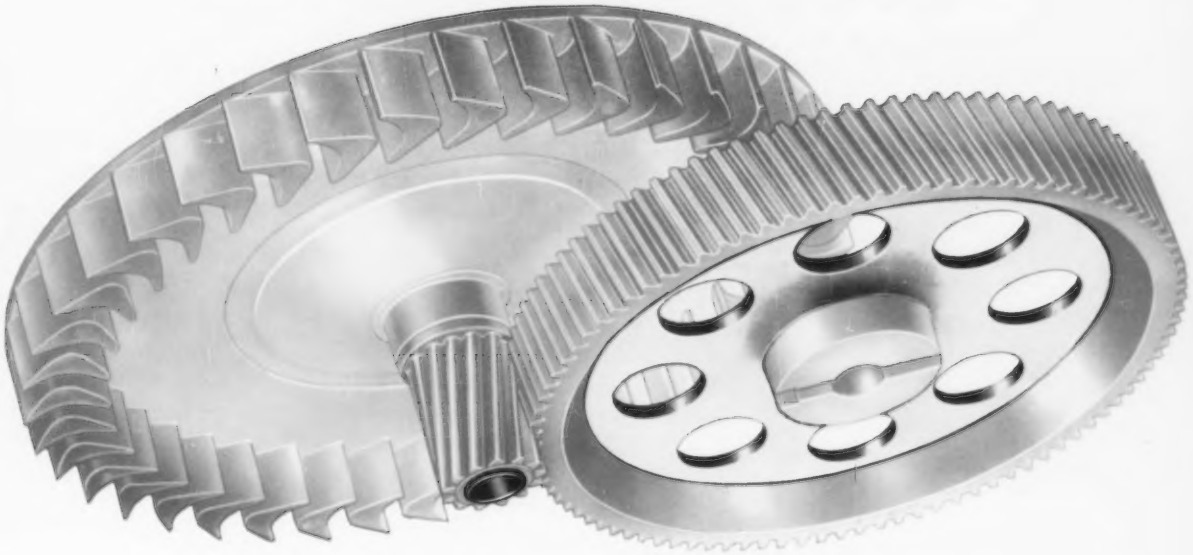
PRODUCT ENGINEERING NEWS
LATEST PROPERTY AND APPLICATION DATA ON ZYTEL® nylon resins

Turbine wheel of ZYTEL® nylon resin runs new vacuum-powered tool



TURBINE WHEEL AND DRIVE GEAR molded of ZYTEL nylon resin power the new *Turbotool*® attachment for Electrolux vacuum cleaners. (Molded by Westplex Corp., Rochester, New York, for Electrolux Corporation, New York, New York.)

A simple turbo-motor runs the home-workshop attachment used with the Electrolux vacuum cleaner. Indrawn air rotates the 4″ turbine of ZYTEL at high speed. Power at the chuck head is said to be greater than for most household electric drills. Centrifugal stresses are far less than for a metal construction, due to the low specific gravity of the material (1.14).

ZYTEL can be molded to the high-precision dimensional requirements of the turbine. The buckets mold clean, smooth and true—without flash. A projecting drive pinion of ZYTEL and a metal shaft insert form part of the turbine wheel. The large gear driven by the turbine is also molded of ZYTEL around a metal web.

Mechanisms that would require an assembly of many parts if made of other materials, are often molded from ZYTEL nylon resin as a single part, requiring no finishing operations. Injection molding of ZYTEL produces precise, complicated parts on a mass production scale . . . and at low cost. Components made of ZYTEL are extremely strong and very resistant to wear. They display excellent heat and impact resistance. Little or no lubrication is needed for smooth operation.

Learn how Du Pont ZYTEL can help you reduce the cost of your new appliance designs. Return the coupon for the facts on its wide range of properties and uses.

OVER

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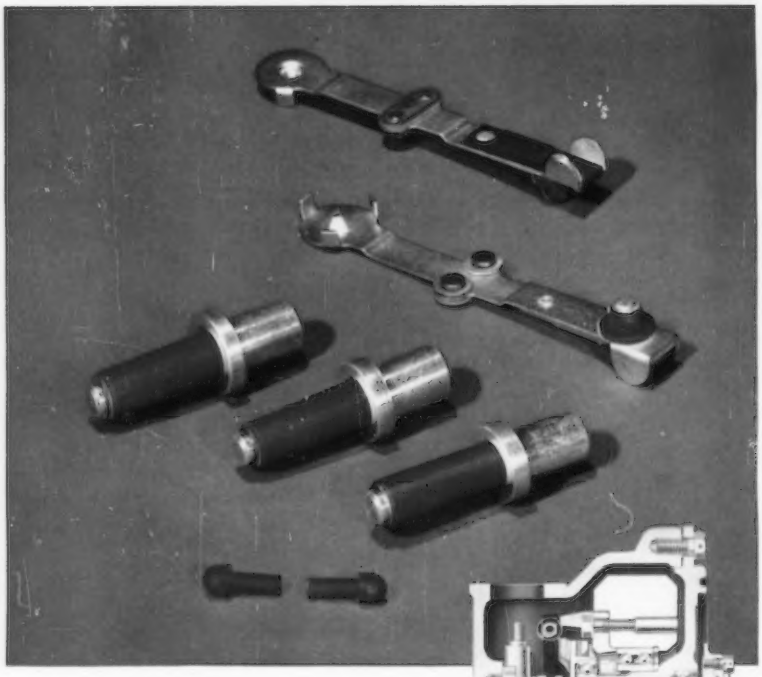
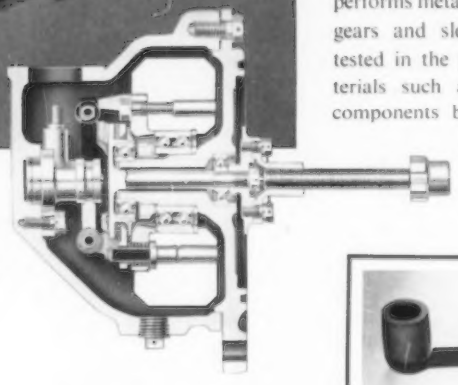
PRODUCT ENGINEERING NEWS

LATEST PROPERTY AND APPLICATION DATA ON

ZYTEL® nylon resins

Durable parts of Du Pont ZYTEL® nylon resin improve operation of train braking device





BRAKE CONTROL MECHANISM mounted on the axles of railroad trains prevents wheel skidding. By automatically regulating brake pressure, it provides maximum braking by preventing the wheels from locking. Parts redesigned with abrasion-resistant ZYTEL eliminated a problem of fretting corrosion, thus insuring proper electrical contact in the unit. Above—new leaf springs, guide pin assemblies and locator pins made with ZYTEL. Shown at right—"Rolokron" axle unit by The Budd Company, Philadelphia, Pa.

Problem of fretting corrosion and faulty contacts eliminated

A vital train braking device sometimes failed to function due to improper electrical contact. This was traced to a heavy accumulation of "red dust," which is the residue of fretting corrosion. The trouble was overcome by redesigning the parts whose minute movements were the source of the corrosion. Using Du Pont ZYTEL nylon resin, metal-to-metal rubbing contacts were eliminated. ZYTEL proved itself in service, providing extremely high wear resistance and good electrical insulating properties.

ZYTEL has the highest strength-to-weight ratio of any resin. It often outperforms metal parts. For instance, both gears and sleeve bearings of ZYTEL, tested in the presence of abrasive materials such as sand, outwear metal components by far. Mechanical parts of ZYTEL are highly resistant to blows and shocks . . . need little or no lubrication.

PIPE STEMS are molded of ZYTEL in natural, white, black and metallics. Practically unbreakable, the stems are threaded to accept a variety of bowl shapes. ZYTEL is rated for intermittent operation up to 250° F. For continuous operation at such elevated temperatures, heat-stabilized grades are available. (Molded by Boonton Molding Co., Boonton, N.J., for National Briar Pipe Co., Jersey City, N.J.)

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PERSPECTIVES

in design and development . . .

Our New Special Assistant

Dr. James R. Killian, Jr., scientific advisor to Pres. Eisenhower, has an indefinite and difficult assignment. There are rumors that he has been told to keep hands off by Secretary of Defense McElroy, that other government officials and committees, as well as the services, are trying to disregard him, that his assignment duplicates that of the President's Committee of Scientists & Engineers, that Missile Coordinator Holaday is operating independently.

Who Is Killian?

James R. Killian was born in Blacksburg, SC, 53 years ago. After a couple of years at Duke, he transferred to MIT, where he received his Bachelor of Science in 1926, graduating with Tau Beta Pi and Phi Beta Kappa. He immediately joined the staff of *The Technology Review*, M.I.T. magazine, of which he was editor from 1930-39. He became executive asst. to Pres. Compton of M.I.T. in 1939, executive vice-president in 1943, vice-president in 1945, and president in 1948. He holds some 13 honorary doctorates, plus the Medal of Merit and an Army Certificate of Appreciation for his work on various committees in Washington. He thus has a broad background in both educational and governmental administration.

Killian and The Humanities

Much of his time at MIT was spent directing the engineering student towards an appreciation of the humanities. He has said, "The specialist must shun the view that lopsidedness is laudable. He must be politically and morally responsible. He must test his actions by their human impact." To the 1955 graduating class he said: "Serve as expositers and exemplars of the true spirit of science and the other noble disciplines whereby man seeks to understand the universe and himself. We have been living in a period marked by both subtle and gross assaults on the intellectual life. The whole domain of science has been especially subjected to barbarian infiltration and the misrepresenting propaganda that it endangers man's nobler aims and ends. You and we have an obligation to make this true character of science better understood."

As a direct result of Killian's efforts, "Course XXI" was started, in which 40 per cent of an engineering student's time is spent in studying humanities. Here the internal history of the evolution of scientific and technical ideas is traced, with special emphasis on the effects that these ideas have on society, and vice versa.

Dr. Killian is also on record that the peaceful applications of science are far more important to our security in the long run than augmenting military strength. The massive struggle against the Russians, he told Congress, will not come on the battlefield but in the factory.

His Opinion of Military R&D

Some idea of Killian's ideas is given by his own statements. Here are typical ones, as quoted in *The New York Times:*

"1. Sound organization can help, and poor organization hinder, the effective management and use of research and development in the Department of Defense, but even with sound organization progress will be retarded unless both the top civilian and military officers . . .

(Continued on page 53)

Look to Skinner in '58

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Most important, these new valves will give you performance and applications that heretofore have not been possible!

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enunciate and follow policies which give research and development proper emphasis and urgency. I think this is fundamental.

"2. Neither (research nor development) is effective simply by the rule of spending money. The real effectiveness comes from brilliance and from the capacity of the men who are conducting the research and development. A hundred mediocre or even average scientists, or even a thousand, cannot be equivalent to one first-rate man working in an environment where he has freedom to exercise his imagination.

"3. Many of the technological advances that helped us to win the last war, such as radar, the atomic bomb, the proximity fuse, were the result of the free-wheeling methods of outstanding academic scientists and engineers who had always been free of any inhibiting regimentation and organization.

Don't Fence Us In

"4. There is a tendency at the present time to decry this kind of creative thinking about military technology and its applications, and to urge that it be replaced by more conventional cut-and-dried procedures.

"5. In the period of rapid technological change such as the one we are in, I do not see how the Chiefs of Staff or even the Joint Chiefs can effectively make policy decisions without a full understanding of the impact of the new technology on tactics and strategy.

"There has been occasional evidence that at times some of our top military leaders have been uninformed by their staffs about technological developments relevant to the decisions they were making.

"6. I feel that the inherent characteristics of a military organization make it very difficult to operate a creative research organization. (We need first, the adequate education of a group of officer personnel in the field of science and engineering and the provision of adequate current opportunities and incentives to make science and engineering attractive as a field for first-rate officers.)

"7. There is now no widespread recognition in either the Army or the Air Force of men with special interest and competence in the field of research and development within the services, and I think this is the greatest single deterrent to the adequate management of research.

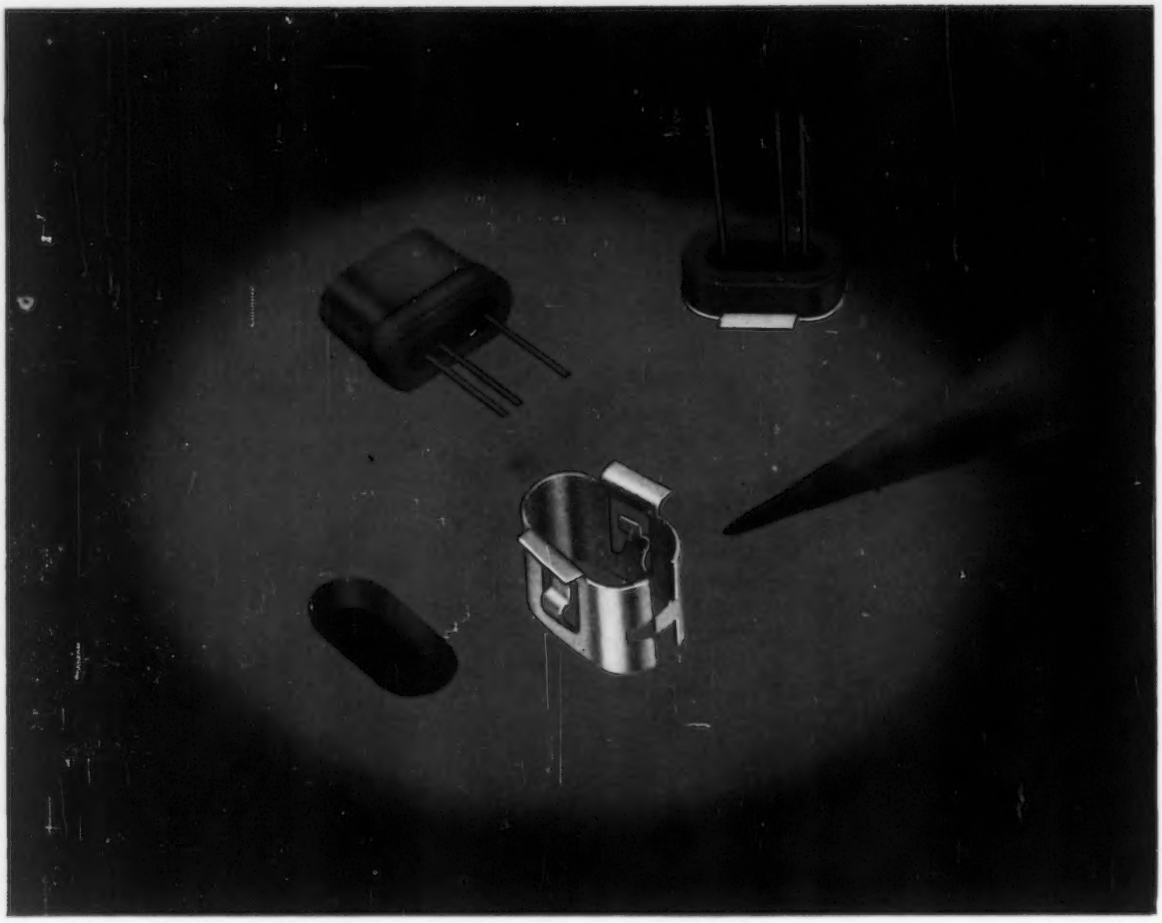
The Security Problem

"8. Finally, I suggest we must achieve a better understanding and rapport between the Government agencies involved and our civilian scientific and engineering activities involved in these fields. In fact, I would put this latter need at the head of the list.

"The problem has now come to be one of various trends, movements and policies in this country having created a condition where members of the scientific community are clearly discouraged and apprehensive about the lack of understanding of scientific methods and in undue regard to what sometimes seems to be a preoccupation with security procedures and policies at the expense of scientific progress."

These Are But Samples

Obviously, Dr. Killian believes the Pentagon needs reorganization, the government should take a clearer, more positive lead, the security procedures need revision. These statements are the more important when it is realized they were made *almost four years ago*, when Dr. Killian was an advisor to various government departments and agencies. Here were sound ideas that would have kept us in the scientific van, ideas that no one has attempted to use. The government has stalled on them all this time—to our everlasting shame. —EJT



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Product Engineering

January 6, 1958

WHICH: how or why?

Early engineers were all "how" men; they sought *how* to do each thing better. Thus they were the men who first operated steam engines, the men who first did the planning and supervision of construction. They solved most of their problems by applying a knowledge of mechanics and a skill with tools.

But engineering has now moved into the "why" problems as well—problems that were once the domain of the scientist and philosopher. Engineering problems of today are very complex, very difficult, often involving analysis as an extensive prelude to actual design and test.

As a result, efficient engineering of today involves much more mathematics. John D. Ryder, dean of Engineering at Michigan State, said recently: "As the mathematical training of the engineer has increased, he has found that mathematical prediction and analysis is a faster and much cheaper means of gaining new knowledge and understanding of our world. Thus he has learned to place more reliance on mathematics and has reduced his usage of the physical model and of the laboratory. This statement, however, applies only in those areas in which mathematics has been developed which will yield answers, the end result of engineering thinking."

Here is expressed an opinion supported by increasing numbers of engineers—that more knowledge and better application of mathematical theory is cheaper and faster than cut-and-try. It is claimed to be surer, too—providing the engineer who uses it is a competent mathematician and his analysis is correct.

These two provisos spell trouble if the engineer's training is of the conventional variety. He has learned to "build and test", and has the necessary skills for both. But his math theory and analytical training may be somewhat weaker.

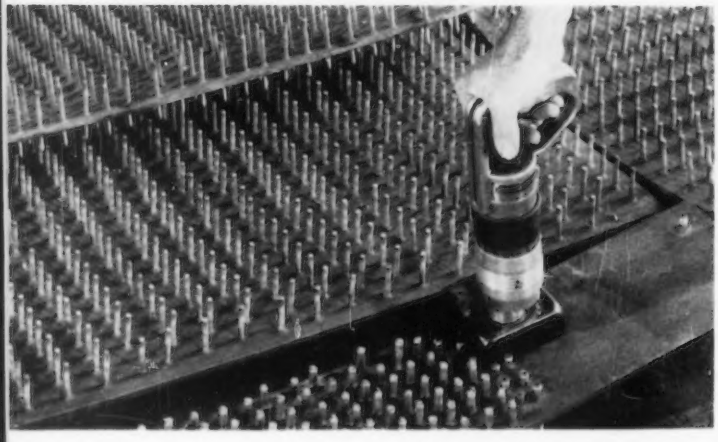
Presumably, future generations of engineers can be provided with this background, at some cost in lab cut-and-try time. But what of the engineers practicing today? And what of the humanities they'd have engineers learn as well? And what of the "well-rounded men", with time to relax, to talk to people, to explain what they're doing . . . that engineers are also expected to be?

There is good evidence that the engineer must be a superior sort of student to get his degree initially. And current news reports indicate that the working engineer is likewise a "brain." Is he now expected to be a paragon?

If he is, we'll never have anything like enough "engineers" to meet predicted requirements.

Baby rocket . . .
delivers 40-lb thrust, yet weighs little more than half a pound, is less than 5 in. long, 1½ in. dia. Applications: It might be used for emergency cutoffs, machine shutdowns, materials testing. Atlantic Research Corp. designed it.

EXPLOSIVES become



Powder-actuated stud-driver . . .
is commercially available, uses .22- and .32-cal cartridges; studs penetrate steel and concrete. Remington makes this one.

ANNESTA R. GARDNER
Associate Editor

**Units can be tailor-made to supply a light tap—
or a thrust that will stop a runaway locomotive.
Here's how to put the rocket-powered and powder-actuated energy sources to work.**

Rockets are now being trimmed down to the size of machine components. Explosives are being engineered into safe, reliable power packs. Already under test are devices aimed at handling a host of jobs—stopping and starting engines, lifting weights, forming metals, driving pistons and turbines, operating portable tools.

All this represents a twin-pronged approach to a new applied-energy horizon—packaged power units that can be tailor-made to deliver anything from a light tap to a thrust strong enough to stop a runaway locomotive. They can be classified in two main types:

Some decompose at an extremely high rate, producing a shock wave measured in thousands of feet per second. This is the explosive or detonation type.

Others burn on the surface at a rate measured in units of inches per second. This is the solid propellant type—rocket or gas generator.

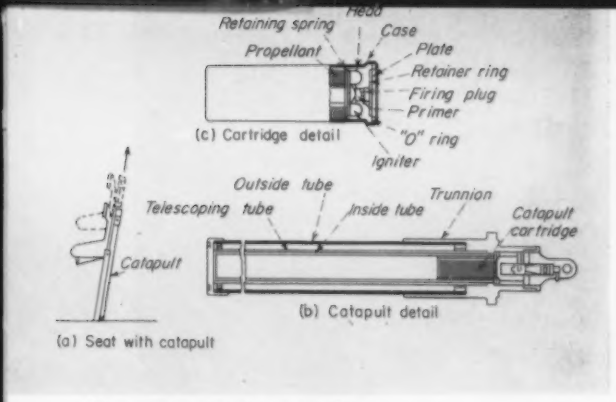
As F. A. Warren of Southwest Research Institute points out, either type may be actuated electrically or by a primer-and-igniter device. Both can be made resistant to activation by other means. Both can be made safe, noncorrosive, compact, light in weight.

EXPLOSIVES GO MODERN

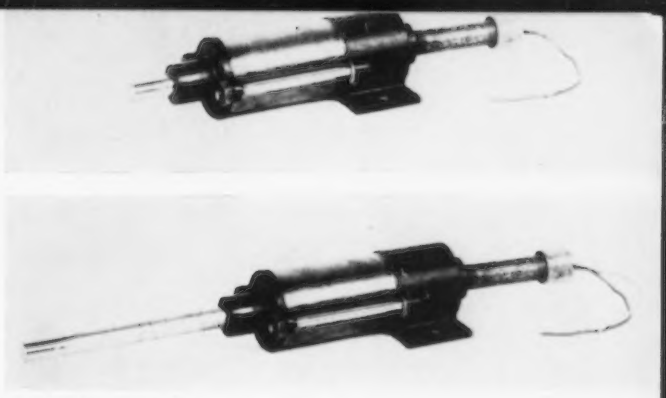
The idea itself of using explosives and propellants in operating mechanisms is not new. It is almost as old as explosives themselves. But two factors are new:

1. High-energy compounds now available are much improved over those of even three years ago, and their design potential is much greater.

2. In many cases, the requirements of today's materials and machines have outstripped the capabilities of conventional mechanisms. A new approach is needed.



Gas-generator cartridge . . .
activates seat-ejection catapult for aircraft use, but design simplicity makes it easy to adapt for industrial jobs. Southwest Research Institute shows how cartridge fits into catapult, and how unit is installed in a plane.



Explosive squibs . . .
powered by standard cartridges can be used to lift weights; close or open electrical circuits, safety valves. Here's one before and after firing. Atlas Powder says it will lift a 100-lb weight 2 in. in an elapsed time of 0.08 sec.

portable power packs

Outboard motors are an example. They're getting so big that manual starting is impractical. Battery starters haven't been entirely satisfactory. Why not a propellant or explosive? As a matter of fact, several attempts were made to devise cartridge starters for outboard motors years ago. But the cartridges were not reliable, particularly if they got wet; and corrosive combustion products posed serious problems.

Now, it looks as if both of these objections can be overcome. Many of today's high-energy devices are amazingly reliable (says The Martin Company, "Our data show an average of only 1 failure per 10,000 tests"); and smokeless, noncorrosive solid propellants having low combustion temperatures are being developed. This means it's time to take a new look at cartridge starters here—and many kindred applications as well.

Because the propellant industry was a war baby, and is still deep in defense work, civilian uses of high-energy compounds have had to take second place. But they are growing. Right now, besides outboard motor starters, the list includes brake actuators, explosive bolts and rivets and frangible studs, stud-drivers, cattle-stunners, fire-fighting equipment, oil-well perforating and cementing tools, and weight-lifting devices. Under active test are metal-forming applications, diesel-engine starters, temperature-sensing mechanisms and driver-training devices, zero leak valves, and audible signal generators. Other possibilities include cable cutters and splicers, auto jacks, truck brakes, machine-tool emergency shut-down devices.

UNCOMPLICATED METHOD

One of the most attractive features of these devices is their basic simplicity. The temperature-sensing device and the driver-training unit are good examples.

The temperature-sensor is really nothing more than a special type of solid propellant which will ignite and burn the instant it reaches a specific temperature, yet is stable until it reaches that point. Already, materials of this type are being readied for the 300-F to 500-F range. (This is actually above the auto-ignition point of most propellants now in use; but propellant manufacturers believe the goal can be reached by proper compounding.)

The driver-training device is also remarkably simple. Primary elements are two powder-filled cartridges that will eject a white dust onto the roadway. One cartridge is activated when the instructor gives the order to stop; the other as soon as the student driver applies the brakes. The distance between the two markings then indicates the student's reaction time.

In these applications, it is instantaneous response to a stimulus that makes propellants useful.

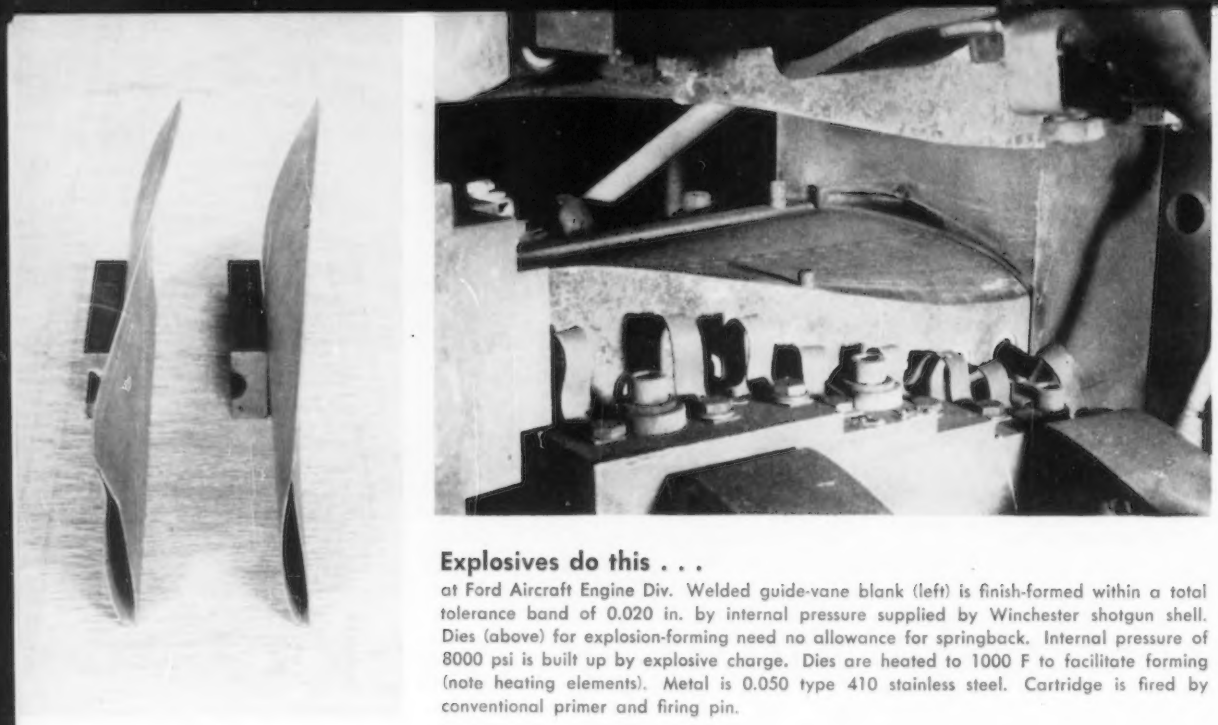
SHAPING METALS

In metal-forming, it is fast delivery plus high energy that makes it possible for these materials to perform unusual feats, particularly with such recalcitrant metals as titanium and stainless steel. They are difficult to shape by ordinary die-forming methods because of excessive work-hardening and the resulting springback. But an explosive or propellant acts so fast it apparently is able to force the metal into shape before it has a chance to resist.

Several jet-engine and airframe manufacturers are now using high-energy materials to form such parts as turbine guide vanes—particularly for final shaping operations. (Conventional methods are usually satisfactory for rough forming.)

At Ford Motor Company's aircraft engine plant, for example, a complex forming method involving expensive dies and a special wax fitting was required to form stainless-steel guide vanes. Now, shotgun shells do the job quickly and efficiently.

Lockheed Aircraft is trying everything from pistols to shaped charges. Both are well satisfied with results so far. The key design problem, they point out, is loca-



Explosives do this . . .

at Ford Aircraft Engine Div. Welded guide-vane blank (left) is finish-formed within a total tolerance band of 0.020 in. by internal pressure supplied by Winchester shotgun shell. Dies (above) for explosion-forming need no allowance for springback. Internal pressure of 8000 psi is built up by explosive charge. Dies are heated to 1000 F to facilitate forming (note heating elements). Metal is 0.050 type 410 stainless steel. Cartridge is fired by conventional primer and firing pin.

tion of the charge. Its force must be directed at exactly the right point to be fully effective.

Propellant energy for metal-cutting is another promising possibility. Says Aerojet-General Corp.'s Explosive Ordnance Div., "It is as easy to slice a railroad tank car with explosives, as we have done, as it is to cut it with a blowtorch, and it is infinitely faster and neater. In fact, it is possible to cut safely hard materials of almost any size or shape."

It should be noted that many of the devices mentioned above are still in the early stages of development. Not all of them are likely to prove practical. Indeed, there are those in the industry who hold out little hope, on a long-range basis, for some explosive-powered equipment now offered commercially.

ROCKETS FOR RUNAWAYS

Several companies, for instance, are quite enthusiastic about the possibilities of propellants for emergency braking of heavy trucks; while others are doubtful and one states flatly, "The idea of using rockets as emergency braking power on runaway trucks represents a fundamental misconception of the kinds of things a propellant can and should do."

Taking something of a middle course, Robert White of Grand Central Rocket Co. doesn't write off truck brakes completely, but does point out there is more to an application of this type than just designing the rocket to do the job. "The theory is that if a large truck lost its hydraulic braking power on a downhill run, a rocket could deliver a forward opposing thrust that would bring the truck under control."

But what would happen to the motorist in the car ahead? He might well get cooked by the rocket blast. Considering the problem from both angles, White continues, "We came to the inescapable conclusion that it would probably be better to let him get run over by the truck then to disintegrate him with a rocket thrust." He thinks the problem could be solved, but it would certainly need a lot more work.

With locomotive brakes, a different problem arises. There is little doubt, says White, that a rocket could be designed to do the job, and safety problems would not be acute. But the rocket would be a big one—and expensive. The question here becomes: How many runaway trains are there? Would railway companies be willing to pay a stiff price to equip all their trains with rockets on the off chance that one might go out of control on a down grade?

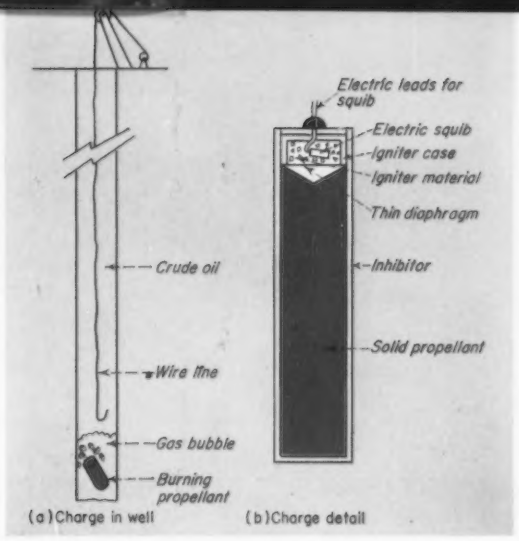
PACKAGED POWER

When should the design engineer consider these power packs? In general, explosives and propellants can be put to work in three ways:

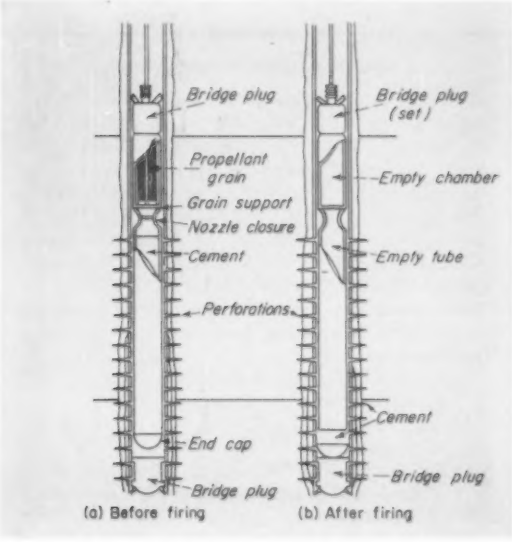
- **As direct source of energy or thrust for a pushbutton or piston-type application.**
- **As a gas generator to operate a turbine, provide energy for driving a stud, or pressurize a chemical reactor.**
- **In rocket-type devices—here the gases expand through a nozzle, providing a controlled force or thrust, which can be used to effect movement.**

Explosives and propellants rate consideration, then, whenever there is need for a compact device, capable of delivering substantial amounts of energy in an extremely short time; or a source of hot, compressed gas is needed on an intermittent basis. (Temperatures of 3000 F or more and pressures to 100,000 psi can be developed.)

As compared to standard mechanisms, they have many advantages: They can be packaged in almost any size and shape, in materials ranging from magnesium to glass-reinforced plastic. They can be located right where their energy is to be applied, often



Oil-well tools . . .
include gas-generator (above), and squeeze-cementing tool (below). In gas-generator, electric squib serves as igniter for solid propellant. It induces oil flow. Tools of this type are now in commercial use. The squeeze-cementing tool is a fast-acting, efficient device that, as Southwest Research Institute points out, helps solve long-term oil-industry problems: prevention of seepage of water into well when walls are perforated.



making it possible to eliminate many feet of connecting tubing that would be required for an hydraulic or pneumatic system; yet they can be remotely controlled if desired.

Rockets constitute somewhat of a special case. As D. O. Myatt of Atlantic Research Corp. points out, in terms of propellant energy a rocket motor is inefficient compared to a cartridge-actuated device. But its reliability over an extended period, the large output of force which can be obtained from a motor small in size and weight, and its inherent safety (the force will not exceed the rocket thrust, even under the most adverse conditions) should make it particularly attractive for emergency (single-shot) or infrequent requirements where quick application of force is required.

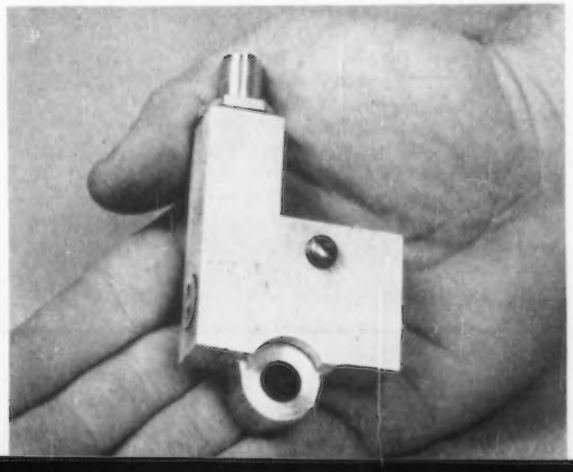
WHAT'S THE PRICE?

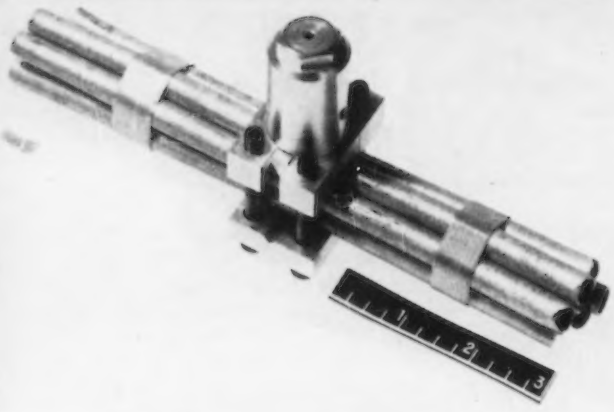
Perhaps the biggest question for the potential user—particularly in connection with the newer propellant-operated devices—is that of cost. Most of today's units grew out of the aircraft industry; and as one engineer frankly points out, "No one is going to quibble with a unit that costs $1,000 or $10,000 if it will save a life or a million-dollar airplane."

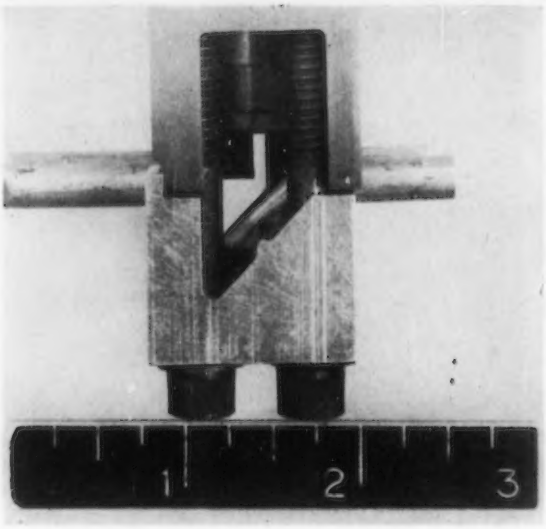
Cost, in other words, has not been a primary consideration; and producers of commercial-type rockets and propellant mechanisms talk in terms of $100 or $200 per unit. On the other hand, it should be noted that a device which costs $100 and will save a $10,000 press; a whole plant—or a man's hand when used as an emergency shutdown—is certainly worth its cost. Furthermore, present prices represent design and development costs and single-unit production. On even a moderate-production basis, it should be possible to bring unit costs down to $25 and perhaps even $10. Furthermore, standard cartridges used in such devices as a stud-driver are already low in cost—and can be adapted to many machine applications. Thus, this question, while it rates consideration, is not as serious a limitation as it might seem at first.

For information on propellants and explosives, the

Refillable and multipurpose actuators . . .
shown below, designed by Propellex, Inc., are headed for commerial use. Refillable actuator (left) is for emergency operation of aircraft landing gear. It supplements hydraulic unit, feeds compressed gas directly into hydraulic lines (note large hole in foreground). Propellex says it can be produced in quantity at moderate cost. Multipurpose actuator (right), designed as aircraft pilot-ejection device, cuts restraining cables, releases safety harness and foot-retainers.







Cartridge-activated tube-cutter . . .
not only slices through stainless-steel tubes (¼ in. dia, 0.035 wall), but also seals them (right) to prevent escape of pressurized gas. Made by Aerojet-General, it has non-corrosive propellant, weighs less than 1 lb, can be reused.

obvious place to start is with the suppliers of standard explosive cartridges. If a commercial shell will not do the job, it's time to turn to the research organizations concerned with the development of rockets and propellants, the manufacturers of high explosives and jet fuels, and the rocket builders. It seems a good idea, at least at the start, to lean heavily on the design experience of engineers now in the field. This, naturally, is their view. But they make several good points.

Designing a high-energy device is not a simple matter. To be sure, there is now a whole stockroom full of propellants, and all sorts of permutations and combinations are possible; a good deal of know-how on propellant geometry (the actual shape of the charge) has also been built up so it is possible to deliver energy in almost any amount either at a constant, accelerating or decelerating rate. But much of the information is classified, either for security or patent reasons; there are no up-to-date textbooks on the subject; and much of the periodical literature, while it has become voluminous, is incomplete.

CONFIDENCE VS PROBLEMS

Too, there are still plenty of problems to be solved in connection with high-energy compounds. For instance, W. R. Davison, manager of program analysis in the Rocket Fuels Div. of Phillips Petroleum Co.'s R & D Dept., says, "The design problems surrounding the use of solid propellant power packages are generally those related to high temperatures and high pressures (but) there may also be problems associated with bonding two dissimilar materials together, and with the satisfactory ignition of the propellant."

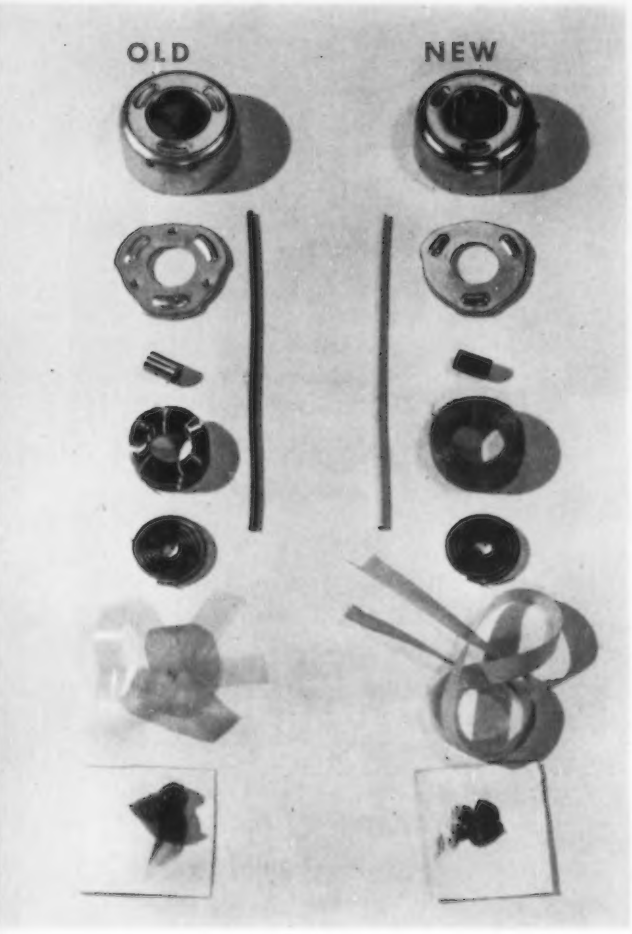
Those who are working on propellants and explosives have tremendous faith in their ability to turn those war babies to civilian use. It's a faith that seems well justified, though it may take longer to develop and prove out civilian applications than some believe. But the sky is no longer the limit. It's only the beginning.

Says Robert A. Cooley, president of Propellex Corp., "We were even invited to consider development of a propellant-actuated baby-cradle rocker 'so mothers wouldn't have to worry about tripping over an electrical extension cord.' We turned the job down. Not because it couldn't be done, or because it could not be made safe enough for baby, but because of the educational program that would be needed to develop the market." That last statement probably applies to the industrial market as well. But here the educational program should be easier—and certainly worth the effort.

WHERE TO GET INFORMATION

High-energy power packs for industrial use are developing so fast that much of the information on them is still classified for patent, if not for military, reasons. Too, many companies that may be leading suppliers in the future are still too involved in satellite and weapons development to explore the civilian field. The list below, therefore, should be considered as a starter, rather than a definite compilation. It does, however, include representatives of each of the four major information sources—research institutes, rocket designers and builders, ammunition producers, and high-energy fuel manufacturers:

Aerojet-General Corp., Azusa, Calif.
American Rocket Co., Wyandotte, Mich.
Atlantic Research Corp., 901 No. Columbus St., Alexandria, Va.
Atlas Powder Co., Wilmington, Del., and Parke Thompson Ordnance Section, 9404 Watson Road, St. Louis 19, Mo.
E. I. duPont, Wilmington, Del.
Grand Central Rocket Co., P.O. Box 111, Redlands, Calif.
Hercules Powder Co., Wilmington, Del.
National Northern Div., American Potash & Chemical Corp., P.O. Box 175, West Hanover, Mass.
Olin-Mathieson Chemical Corp., 460 Park Ave., NYC, and Winchester-Western Div., Alton, Ill.
Phillips Petroleum Co., Rocket Fuels Div., Bartlesville, Okla.
Propellex Chemical Corp., P.O. Box 187, Edwardsville, Ill.
Remington Arms Co., Bridgeport 2, Conn.
Southwest Research Institute, 8500 Culebra Road, San Antonio, Tex.
Standard Oil Co. (Ind.), 910 S. Michigan Ave., Chicago 80, Ill.



HOT SOLENOID

OLIN K. SMITH
Chief Engineer, G. H. Leland, Inc.

Problems solved in redesigning a rotary solenoid for 500 F service

Almost all materials used in our standard rotary solenoid were unsatisfactory at 500 F. Cadmium plating and cyanide case-hardening for 1010 steel did not stand up. Bronx sleeve bearings, lubricants, and the 18-8 stainless return spring were no longer adequate. Mylar tape, vinyl sleeving and varnish-insulated wire failed. New materials had to be found to withstand 300,000 operations in 48 hr while temperature was maintained at 500 F. Here's why:

Temperature range for an electromagnetic device is a bigger problem than maximum temperature. Unit may be put into service while at −65 C and span the entire range in seconds. **Dielectric properties** at elevated temperatures may call for testing under new conditions. **Corrosion resistance** of many materials may be widely different at high temperatures. **Endurance life** at normal temperatures is no indication of life when operated hot.

Here—side by side—were the answers found for this solenoid.

Finish on case and armature changed from cadmium-plated cyanide-hardened to nickel-plated nitrided. Material remained 1010 steel.

Sleeving changed from vinyl to glass fiber treated with silicone rubber.

Bearings were bronze; changed to carbon.

Magnet wire was single Formvar; replaced by single glass-insulated wire.

Return spring changed from 18-8 stainless to 17-7 PH stainless age-hardened.

Coil insulation was Mylar, changed to fiberglass tape treated with silicone rubber and resin.

Lubricant, a MIL-G-3278 grease, was replaced by dry Molykote G.

NEXT GOAL 850 F, THEN 1000 F

Problems of the electrical coil and insulation may be solved by nickel-clad copper with glass or ceramic insulation. For a suitable magnetic material we suspect nitrided 410 stainless may do. Corrosion resistance will probably be met only by precious-metal plating. For the spring Inconel X looks good, and a ceramic for the bearing.

Some forms of moly-disulphide show promise for the lubricant although both the material and method of application are uncertain yet.

PRESSING CAN MAKE COMPLEX

Any one operation in pressing is simple—and economical. But why stop there? Here is how combined operations can give complex, one-piece designs.

CARTER C. HIGGINS
President, Worcester Pressed Steel Co.

The economical technique of simple forming in heavy presses is not as limited as one might think. By itself, it is unable to turn out the complicated parts that casting, forging and machining can produce. But incorporate in the process such operations as drawing, ironing, upsetting, coining, stretching—and a variety of complex parts can be made in one piece.

The basic step, simple pressing, owes its fabrication economy to its high production rate and savings in material while it cold-works and strengthens lightweight sheet metal, and use of unskilled labor. Such simple processes as blanking, cutting off, shaving, piercing, trimming, curling, and bending make the heavy pressed parts used in automobile structural members and bumpers, and machine and electrical enclosures—all economically pressed from flat blanks.

When a multiple-step operation is employed, combined costs are higher, of course, than for simple pressforming, but remain lower for certain complicated parts than with casting, forging and machining. The added steps are:

Drawing metal over a die stretches it from a flat sheet to conform to die shape. This is accompanied by a slight change of thickness in the portion drawn.

Ironing thins walls by forcing a drawn cup through a punch and die with opening narrower than thickness of the part. Ironing accurately sizes the part while making it more concentric.

Upsetting parts increases the section by compressive cold-working.

Coining embosses by flowing the metal under pressures in a confined space. This thickens the metal in some areas, thins it in others.

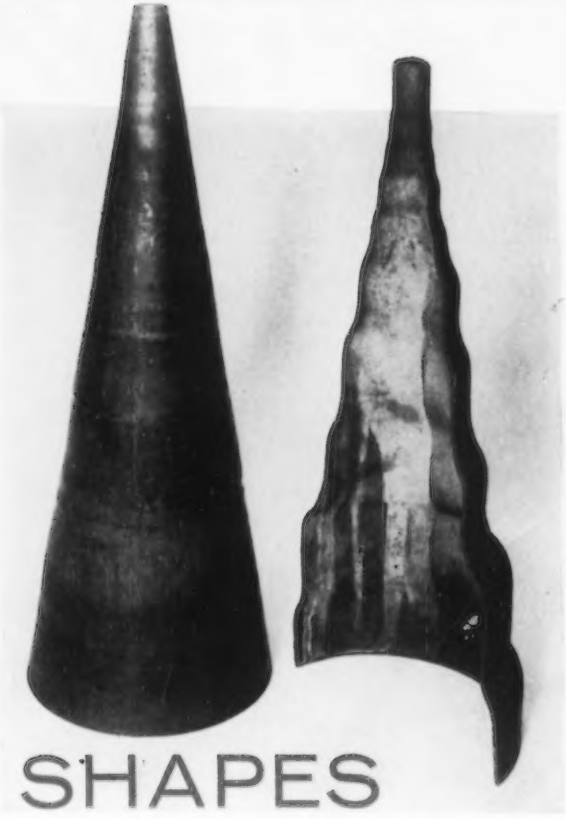
Stretching is the thinning that occurs in side walls during drawing. This is especially pronounced in double-action drawing which grips the flange while the drawing die is advanced.

Extruding metal at holes is accomplished in one operation by a tapered punch which shears the hole and flanges the sides.

WHAT MULTIPLE OPERATIONS DO

The photo above illustrates four interesting applications of the multiple-step method. Too complex for simple presswork, the parts were shaped by successive steps. Shown, left to right, are: propellor dome, ogival cone, stainless pan, motor frame.

• The propeller dome was drawn from a 22½-in.-dia blank of 61-SO aluminum ½ in. thick. The open end was rough-squared, and the dome mouth forced through a die, 9⅜ in. dia. The nose indentation was then increased in section by upsetting, and sufficient metal



SHAPES

drawn from the periphery of the hole for subsequent operations. Several ironing steps made the wall thin while maintaining the heavy flange. This dome, which measures 11¾ by 13 1/16 in. high, is 16 lb lighter than a forging, requires less machining, has a good surface finish, and maintains tolerances of 0.010 in. on the cup dia and 0.003 in. in concentricity.

• The ogival cone, a deep-drawn windshield for a ballistic shell, was made from 0.125-in. hot-rolled steel. It's 7.129 in. at the base and tapers 16 in. to the closed conical point. Simple stamping produced the blank, which was then given two double-action draw operations, was rough-squared, necked eight times, struck on the nose, and sized, with five annealings in between. Ten sets of tools were used. Photo above shows finished cone alongside intermediate stage (sectioned). No welding was needed—pressing alone produced this finished part with a minimum of waste, high unit strength, and a tolerance of 0.003 in. on the diameter.

• The stainless-steel meat-grinder pan exemplifies a complicated pressing made in one piece for sanitary reasons. It is 12¼ in. dia and 5½ in. deep, including the neck, and was made from a stainless blank, 17½ in. dia., 1/8 in. thick. The offset hole was punched; material around the hole was extruded. In all, nine drawings and four intermediate anneals were required. The pan meets a tolerance of 0.005 in. despite springback inherent to stainless steels.

• The cylindrical motor frame shows how tubular parts with various-shaped windows can be made cheaply by pressing. Punched holes have eliminated machining and there is no need to use hard-to-get tubing of special alloys. The blank was cut to 11 by 6 11/16 in. from 0.562-in. sheet iron, then it was notched and the windows were pierced. Now the flat blank was stamped to form a U, and closed to cylindrical shape—with windows accurately located. The heavy material required a 665-ton press for the first forming and a 1500-ton press for closing.

When tubes are pressed, several parts can be cut from a drawn cup. This versatility is limited because costs of intermediate annealing and extra tooling charges can offset the cheapness of sheet material and the higher production rate.

WHERE PRESSING IS LIMITED

With pressing, stock thickness should be uniform and any drastic changes in thickness must be attached separately, or embossed at high pressures and correspondingly high cost.

Selection of materials is confined to ductile metals with yield strength below ultimate. Certain materials are favored for reducing costs and die wear in stamping—for example, SAE 4140 is a good forging material but 4130 has better ductility for deep-drawing. Stainless steels have springback which gives eccentricity and difficulties in maintaining tolerances. Magnesium must be drawn warm, but in thin sections will not hold the heat. Titanium gives a multiplicity of problems: springback, galling, and cracking at sharp radii. Also, the scale which forms on heating must be removed before further work. Maintaining consistent wall thickness in heavy sections is difficult with copper and zinc.

Max thickness is limited to 5/8 in. for steel and ¾ in. for aluminum. Heavier sections require excessive pressing pressures and sturdy dies which are expensive.

Sharp edges and burrs cannot be avoided and removal is expensive. However, parts can be so made that the burred edge is on the interior of the part, making removal unnecessary.

EDITOR'S NOTE: Other recent articles on sheet-metal forming processes:

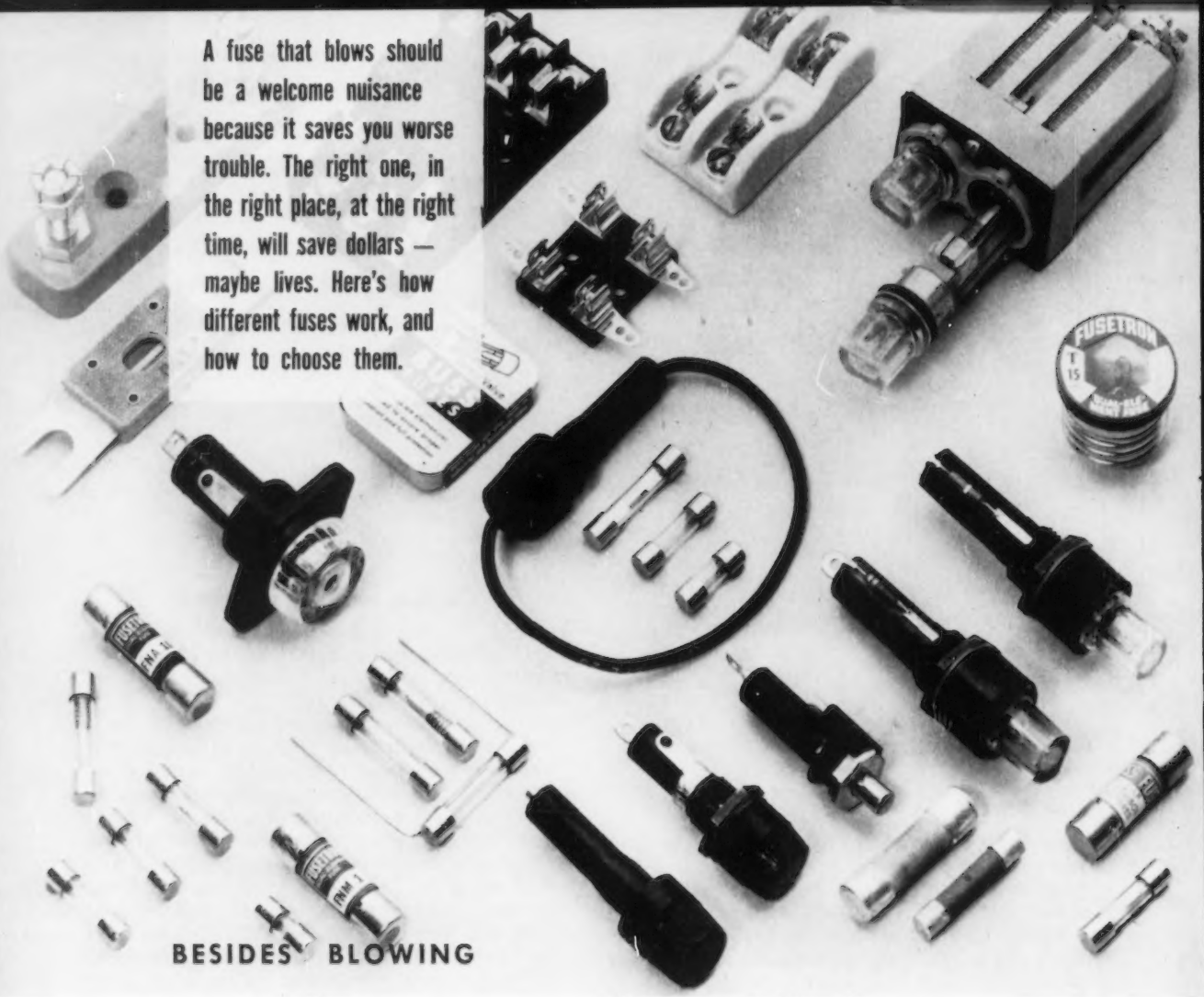
"Forming Titanium Sheet," Feb '56, p 135, and Mar '56, p 175. Explains the differences in elongation, elastic limit, springback and buckling of titanium that require special allowances for bending, drawing and forming.

"Power Spinning Conical and Tubular Parts," Aug '56, p 135. Advantages and limitations over other metal-working processes are given, along with effect of process on strength, hardness and fatigue.

"Short-run Stampings," Nov '55, p 174. How short-run stamping differs in tooling; also gives size and shape limitations and 12 tips for reducing costs.

"Waffle Beading for Stiffening Sheet Metal Panels," Aug '55, p 171. Design and procedures for a method that strengthens sheet metal in all directions without need for reinforcing members.

A fuse that blows should be a welcome nuisance because it saves you worse trouble. The right one, in the right place, at the right time, will save dollars — maybe lives. Here's how different fuses work, and how to choose them.



BESIDES BLOWING

fuses do this

J. C. LEBENS, *Vice-president*
Bussman Mfg. Div., McGraw-Edison Co.

A fuse is the link that shouldn't be missing in electrical circuits fed off the power line. Protection against damage from line overload or local short circuit is its one and only purpose. But this doesn't mean that just any fuse can handle any job.

The device must open and clear a circuit safely, and without damage to the fuse assembly other than to rupture the fusing element itself. And remember that some power-supply lines to motors and other electrical equipment can throw thousands of amperes across a short circuit when something goes wrong. These currents can burn insulation, pull conductors from their supports, injure generator and motor windings, transformers, circuit breakers, switches–and endanger lives.

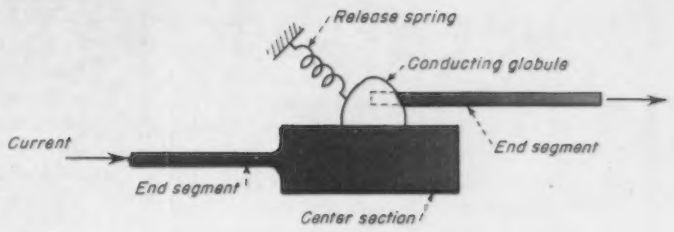
In itself, the fuse is usually a metal link inserted between two terminals. The link is small in cross-section so it will heat and melt when current exceeds its rating. The temperature rise is directly proportional to the square of the current, but because some of the heat is dissipated as it is produced, both time and current govern the melting time. How the links are designed establishes the melting characteristics, and time lags are built-in to meet industry's requirements.

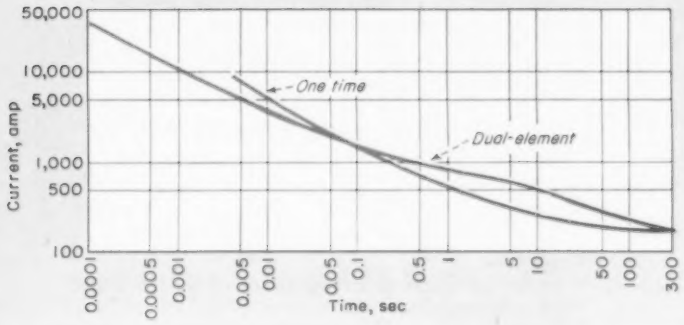
FUSES DO THIS

As weakest link in a chain of current-carrying devices and wires, the fuse prevents excessive current anywhere in the circuit. Besides standard applications, fuses serve to:

- **Limit current at arcing points so an electrical fault will not start a fire.**
- **Keep materials such as glass and ceramic parts of electrical equipment from shattering.**
- **Isolate a defective circuit so the supply line will be**

Dual element fuse . . .
depends on high-temperature end segments for normal fast blow on short circuit. Fusible globule melts on much smaller overloads, but heat-sink function of heavy center section provides time lag; release spring opens circuit.





Time lag . . .
in typical 100-amp, 250-v dual-element fuse allows a moderate overload (500 amp total) for 10 sec compared with less than 2 sec for single-element type of same rating; yet dual type blows more quickly at high overloads (over 1000 amp).

affected only momentarily if at all, and other equipment can go on operating.

- **Prevent heavy currents from melting or welding switch and circuit-breaker contacts.**
- **Keep circuit joints and generator or motor-commutator bars from becoming unsoldered.**
- **Protect meters and test instruments—fuses can be obtained at ratings of 2 ma and up.**
- **Open on short circuits fast enough to prevent damage to thermal or magnetic breakers before they have time to act. (Shorting currents may exceed values the breakers can handle.)**
- **Protect apparatus and interconnected wiring from outside voltages coming onto the line.**
- **Indicate, when failure is frequent or unexplained, that an unsuspected overload or other undesirable condition is somewhere in the circuit.**

DEVELOPMENT OF FUSES

Earliest form of protection was a short length of wire, generally copper, much smaller in diameter than the wire it protected, and in series with it. The wire was in the open, and a fire hazard because copper melts only at relatively high temperatures. Soon lead-tin alloys or zinc replaced copper. Melting at lower temperatures, they eliminated danger from spattering high-temperature metal. And with zinc links, the cartridges did not explode or emit either flame or molten metal–an important safety advance.

Another improvement was a fuse block with cover; it confined the spattered metal and arc. Later, fuse links were enclosed in fiber, ceramic or glass tubes, and supplied with end terminals to fit clips in the blocks.

Cartridges were filled with sand or inert powders which suppressed the arcs, and also reduced heat convection and radiation from the fuse link. On transient overloads, the mass of material acted as a heat sink to delay rupturing of fuse, but for longer periods the insulated fuse link would melt at lower currents.

In 1904, the physical dimensions of cartridge fuses were standardized by the Underwriters' Laboratories for the 250-v and 600-v classes. The 600-v fuses were made longer than 250-v ones, and both groups so arranged that it was difficult to insert a fuse of much greater current capacity in a cutout designed for a lower rating.

Demands for fuses with easily replaceable links were met with stronger fiber cases and removable end terminals that permitted a new link to be inserted and held within the cartridge. Fillers were dispensed with and the cases vented sufficiently to relieve pressures developed when a fuse blew. Later, to provide a greater time lag on overloads, links were redesigned to have several heavy sections separated by smaller junctions. These junctions were weakest part of the link; they quickly heated on overload and either melted or vaporized, with the heavy portions acting as heat sinks to provide some time lag. On heavy overloads, arcs formed across two or more sections which divided line voltage between them; current was interrupted faster and with less arcing.

DUAL-ELEMENT FUSES

Fuses today are not much different in principle than those built over 20 years ago. The dual-element type receives perhaps most attention and development today because it can have time-current characteristics better

HOW FUSES ARE RATED

The 125-volt fuses (up to 30 amp), and 250-volt and 600-volt fuses (up to 600 amp), are tested on dc supplies capable of delivering 10,000 amp on short circuit, at the rated voltage of the fuse. The fuse body must remain intact. Neither flame nor molten metal should be emitted, and the circuit must be isolated. All fuses must carry 110% of rated capacity continuously with room temperature at 18 to 32 C. They must blow within a stated period, ranging from 2 min for 30-amp fuses to 12 min for 600-amp fuses, at 2 times rated capacity. Underwriters' Laboratories checks fuses for compliance with the National Electrical Code. Acceptable fuses are listed in the Underwriters' publications and the fuses may carry their "inspected" labels.

suited to the safe time-current charactertistics of equipment needing protection.

The center portion of a dual-element link is a heat sink for the current. A globule of low-melting-point alloy holds a cap that makes connection between end segment and center portion. At low overloads, temperature rises gradually until the globule melts, allowing a spring to pull the cap away from the joint and open the circuit. At higher overloads, without time for the center mass to get hot, the end links will vaporize and open the circuit.

FUSING POWER CIRCUITS

Safe current-time relationship in motors, generators, transformers and other electrical equipment depends on heat dissipation and the ability of conductors and insulation to withstand temperature.

Under normal operating conditions, current flow in many electrical circuits can and does vary widely—without injury to windings. The demarcation between safe and dangerous operation is a matter of time for a particular value of current. If the fuse blows much before danger point, the machine is not being worked to its fullest capacity; if too much current is permitted to flow too long, the machine may be damaged or destroyed. For complete electrical protection, a fuse should have a time-current characteristic matching the safe time-current characteristic of the equipment.

Dual-element fuses, for instance, have sufficient time lag to permit the heavy initial current flow required to start motors, yet protect running motors against damaging overloads.

Under the National Electric Code, the fuse rating for a motor is determined by the rated-temperature rise. In ordinary service, fuse rating should not be over 25% greater than the running current for motors rated for 40-C rise, or 15% greater for motors of higher temperature-rise. A smaller motor can sometimes substitute for the next larger size if the overloading is only for short periods, because a long-time-lag fuse of proper rating will protect the motor on excessive overloads. The motor manufacturer should be consulted for this information.

NEC frequently permits smaller switches and cutouts in motor circuits with time-lag fuses than with quick-blowing fuses. It recognizes that starting currents can be higher than actual fuse rating, because being momentary they will neither blow the fuse nor damage the circuits.

In motor circuits, correctly rated long-time-lag fuses will prevent motors from running wild if field excitation is lost. In multiphase motor circuits, they will open the active phases in time to prevent damage if one phase is accidently opened.

Transformers, excepting those for welding, should be fused in both primary and secondary. Fuse rating for the primary should be 150% of primary full-load rating; for the secondary, 250%. The effect of inductive circuits on both ac and dc circuits is negligible as far as fuses are concerned.

GOOD FUSING PRACTICE

Fuses protecting generators, motors, transformers, or other equipment subject to transient but harmless overloads, should be located close to the equipment. Other important rules are:

- **More than one unit should not be bridged across a single fuse.**
- **Mount on blocks or panels approved by the Underwriter's Laboratories.**
- **Use enclosures readily accessible to the operator. Fuses mounted in enclosed panels generally operate at slightly lower ratings because of the ambient temperature conditions.**
- **Insure proper fuse replacement by plainly indicating the type and size of fuse at some convenient point near the fuse receptacle. Spare fuses, held in fuse clips, and mounted near the fuse block, may prevent long stoppages and possibly using incorrectly rated fuses.**
- **Hot locations are not objectionable if the equipment is subjected to the same conditions. A rise in the ambient temperature causes the fuse to operate a little quicker with the same current flow.**

SELECTING THE PROPER FUSE

Voltage and current ratings, time-current characteristics, and short-circuit interrupting capacity of a fuse must be considered. Two examples may aid the decision:

- **Standard fast-blow fuses will adequately protect fluorescent lamp circuits and control circuits. They will also protect incandescent lamp circuits, if small motors aren't on the same line, because the initial rush of current is of too short duration to cause unnecessary blowing.**
- **Circuit breakers, backed up by fuses, can be set to trip on overload conditions, letting the fuse take care of faults. Or, fuses can be coordinated with automatic-reclosing breakers so the breaker will respond to transient faults and shut off current before the fuse has time to blow.**

EDITOR'S NOTE:

A properly protected motor may need special relay protection as well as branch fuses. This is discussed in "Motor Overload Relays," Jan '55, p 177; and "Safety in Dc Motor Controls," Dec '55, p 193.

we threw out PRESS FITS FOR BEARINGS

EDWIN F. OBLINGER, *Chief Engineer*
Parker Sweeper Co., Springfield, Ohio

Recent tests at our laboratories indicated that a liquid sealant called Loctite would do away with the need for press fits to retain bearings. We followed the tests by using the sealant in assembly operations and have been gratified with the looser tolerances it allows.

Here is why we were interested. Press fits are commonly employed in ball bearing installations to prevent the bearing races from shifting or rotating with respect to the bearing housing or shaft. This requires precision tolerances on the shaft and housing bore—if the fits are too loose the races will slip and rotate, causing fretting of the surfaces; if too tight the inside race is stretched over the shaft and the outer race compressed in the bore—shortening life of the bearing.

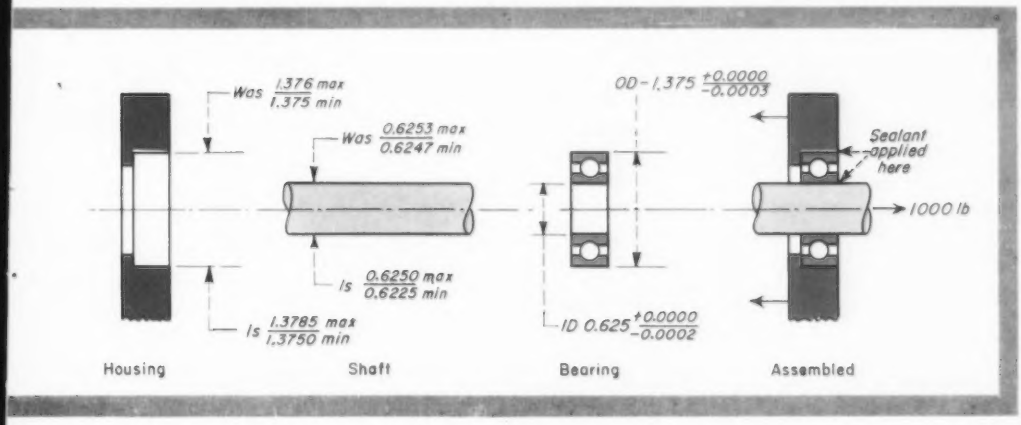
In our particular application, the bearings are part of a small gear box which drives the Parker Turbo Floor Sweeper. The close tolerances led to many parts being rejected, and there were reports of bearing failures caused by cracked inner races. The ball bearings are of the inch series, single-row radial with ⅝-in. bore, as shown in the illustration.

After a series of tests with the sealant it was found that the shaft could be made 0.003 in. under actual bore size of the bearing and still retain the bearing with a force equal to a customary interference fit of 0.0003 in. This permitted opening up the tolerances by 0.002 in. Also, when sealant-treated, the housing could be 0.0035 in. oversize and it would still be equal to an interference fit. These new looser tolerances are now being employed for retaining all bearings in our products.

ASSEMBLY DETAILS

Before assembly, all the parts except the bearings are cleaned and degreased. The bearings are cleaned by hand with a clean dry cloth, and the sealant applied to the surfaces with a small brush. Care is used to prevent an excess of sealant, which could seep under the shaft seals. The assembly slips together easily without any press fits. Because it would ordinarily take 12 hr for the bond to reach max strength, it is heated for about an hour at 150 F, after which assembly can begin.

This procedure has reduced rejected parts from 8% to less than 1%; for the parts needing rework or some modification, either by hand or machine, from 20% to 0. Gear boxes made this way were tested for over 100 hr of heavy service at speeds above our requirements and have shown no indication of failure. A load of over 1000 lb, applied axially along the shaft, is required before the bond between bearing and shaft is broken—an indication of the effectiveness of the sealant. This, however, has made it necessary to have hydraulic equipment for dissembly when repairs are needed.

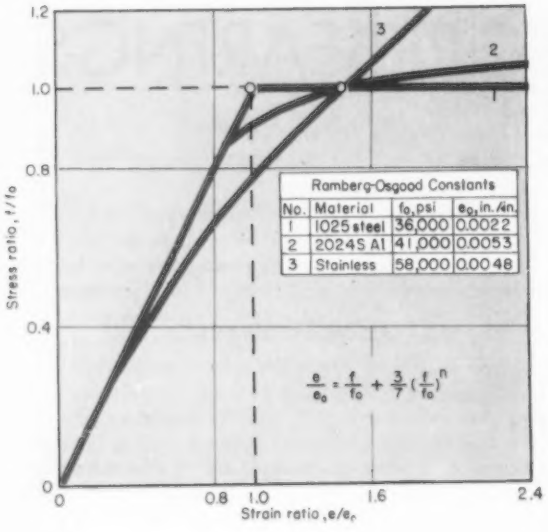


Liquid sealant . . . replaced interference fits and opened up tolerances almost 0.002 in. on shaft and housing for this ball bearing assembly. Load of over 1000 lb is needed to break bond.

What Is This Sealant?

Developed by the American Sealant Co. of Hartford, Conn., Loctite is a penetrating liquid polymer that hardens only after being confined between closely fitted metal parts. Catalytic action of the metal surfaces, aided by the absence of air, is sufficient to harden the sealant into a strong, heat- and oil-resistant bond. It has already found use as a liquid lock for threaded fasteners, as a sealant against porosity in welds and castings, and as a solder for certain types of joints.

The polymer is intended for shear rather than tensile stresses. It is available in five grades; Grade A has the best holding power—up to 1000 psi—and was used in the bearing assembly discussed here.



1 Stress-strain curves . . . in Ramberg-Osgood dimensionless ratio form make comparisons between metals easy, since differences in curves depend only on exponent n.

Table II–Influence of Poisson's Ratio

Poisson's Ratio	Design Constant		
	Shear Modulus $\frac{1}{2(1+\mu)}$ from Eq (1)	Edge-loaded plate $\frac{\pi^2}{12(1-\mu^2)}$ from Eq (5)	Cylinder under torsion $\frac{\pi^2}{12(1-\mu^2)^{0.555}}$ from Eq (6)
$\mu = 0.30$	0.385	0.904	0.874
$\mu = 0.35$	0.370	0.937	0.894
$\mu = 0.40$	0.358	0.979	0.917
Max % Change: +33	−7	+8	+6

S. A. GORDON, *Consultant*
Battelle Memorial Institute

HOW WRONG CAN

Even precise testing methods will give variations. But their effect on accurate structural design doesn't seem to be crucially important. Here's some analysis that shows why.

As new materials appear, their elastic constants are determined with a high degree of accuracy—often at considerable cost in time and money. But is this being too fussy? The questions that arise are: (1) how much accuracy is required; (2) assuming error, how much of it will show up in application of these constants to the more common design formulas?

These questions do not apply to common structural materials. For them, constants like modulus of elasticity E, Poisson's ratio μ, and shear modulus G are well established. But determining new values is a problem because methods are not well standardized and variations will occur even with precise testing methods, probably for metallurgical reasons. Consequently, much testing and considerable controversy precedes selection of constants for each new material.

To answer the questions raised, let us examine carefully the eight design equations in Table I. For simplicity, a single material—stainless W—is chosen for illustration purposes.

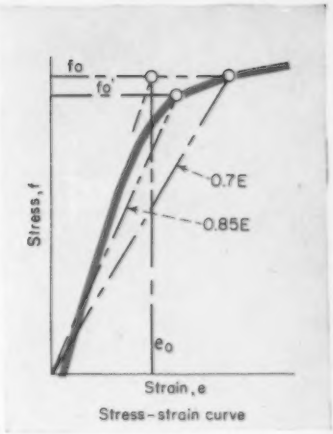
POISSON'S RATIO

In all structural metals μ increases with strain and because its value depends on orientation of the test specimen, selecting a "true" value is difficult. It is usually found by carefully observing the specimen diameter during the tension test, and varies from 0.30-0.40 at low strains, and up to 0.50 at high strains. Three values are arbitrarily chosen for discussion here: $\mu = 0.30, 0.35, 0.40$, giving a spread of 33%.

Shear modulus G is usually computed from Eq (1), though it can be readily obtained by torsion test or by torsional pendulum. If G is calculated from (1) the three values corresponding to the chosen values of μ are shown in Table II. Variation in shear modulus is less than 7%. Since μ increases with strain, the larger value

Table I–Design Equations Containing Elastic Constants

Description	Formula	Nomenclature
(1) Basic relation between elastic constants	$G = E/2(1+\mu)$	G = shear modulus E = Elastic modulus μ = Poisson's ratio
(2) Ramberg-Osgood equation for the stress-strain curve	$\frac{e}{e_0} = \frac{f}{f_0} + \frac{3}{7}\left(\frac{f}{f_0}\right)^n$	e = strain at any point on curve f = stress to produce strain e f_0 = constant base stress for secant modulus of 0.7E e_0 = constant base strain at stress f_0 $n = 1 + 0.385/\ln(f_0/f_0')$ f_0' = constant base stress for secant modulus of 0.85 E
(3) Tangent modulus	$E_t = \frac{de}{df} = \frac{e_0}{f_0}\left[1 + \frac{3}{7}n\left(\frac{f}{f_0}\right)^{n-1}\right]$	Slope of stress-strain curve, or first derivative of (2)
(4) Tangent modulus ratio	$\frac{E}{E_t} = 1 + \frac{3}{7}n\left(\frac{f}{f_0}\right)^{n-1}$	Since $E = f_0/e_0$, (4) is formed by simple ratio
(5) Rectangular plate under uniform edge compression	$f_{cr} = \frac{\pi^2 K \eta E}{12(1-\mu^2)}\left(\frac{t}{b}\right)^2$	f_{cr} = min compression stress at which buckling occurs t = plate thickness b = plate width between loaded edges $\eta = \sqrt{E_t/E} = 1\Big/\sqrt{1 + \frac{3}{7}n\left(\frac{f}{f_0}\right)^{n-1}}$ K = edge restraint coefficient (depends on plate proportions)
(6) Thin-walled cylinder under uniform torsional shear. For large r/t ratios.	$T_{cr}\sqrt{L/r} = \frac{\pi^2 K E}{12(1-\mu^2)^{0.625}}\left(\frac{t}{r}\right)^{1.25}$	T_{cr} = min shear stress at which buckling occurs t = wall thickness r = cylinder radius K = edge restraint coefficient (simple supports, 0.85; clamped edges, 0.93) L = length of cylinder
(7) Column under axial load, pinned ends	$f_{cr}\frac{\pi^2 E_t}{(L/\rho)^2}$	E_t = tangent modulus L = column length ρ = least radius of gyration
(8) Simple beam vibrating in resonance	$E = \frac{A\gamma L^4}{I g}\left(\frac{\omega_r}{\alpha}\right)^2$	A = cross-sectional area γ = density L = length between supports ω_r = fundamental resonant frequency α = constant (3.58 for simple beam) g = gravitational acceleration I = area moment of inertia



Stress–strain curve

elastic constants BE?

of 0.35 seems better as a good average value in design.

Minimum compression stresses that cause buckling in a rectangular plate under edge loading, Eq (5), are influenced by choice of Poisson's ratio. This influence is shown by comparing the constant $\pi^2/12(1-\mu^2)$ for the same three values of μ, Table II. Also shown is the effect on the min shear stresses for buckling of a thin-walled cylinder under uniform torsion. In both cases the variation in buckling stress, as indicated by the differences in the constants, is small.

This comparison shows that Poisson's ratio for reasonably isotropic materials can be approximated safely because large differences show up in only small errors in design. Even if more accurate values of μ were used, greater error would occur by failure to correct these values for the influence of stress level. Further complexity arises in biaxial stress cases where μ is a variable, not a constant. Here, difficulty in formula manipulation makes great precision in the values of μ not worthwhile.

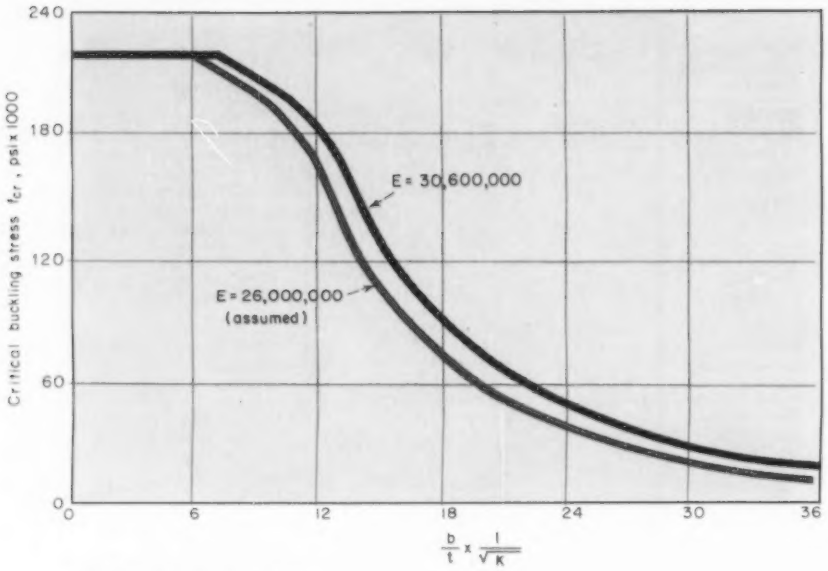
ELASTIC MODULUS

Methods of determining E for structural materials at room temperatures are well established. Careful testing in tension gives accurate values, but compression testing is harder, and compression values of E are less reliable. Dynamic testing, an increasingly popular method at both room temperature and above, is simple and reliable.

Here, a simple beam is resonated by electromagnetic forces at the center of the span. Based on Hooke's Law, the elastic modulus in terms of resonant frequency and geometry of the beam is shown in Eq (8), Table I.

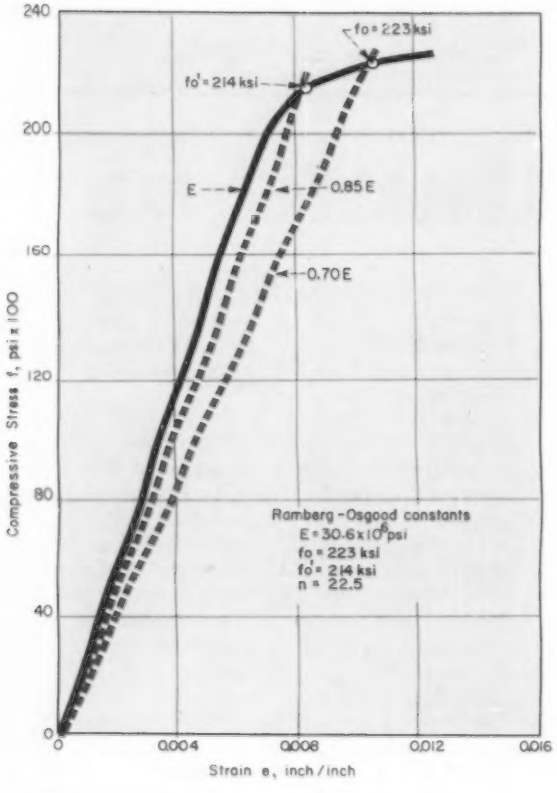
Hooke considered his law, as developed in 1678, applicable only when forces were slowly applied. By 1820, however, the quasi-static restriction was conceded unrealistic. Since then, Eq (8) has been proved valid; static and dynamic moduli are now the same for materials at room temperature—even at test frequencies up to 2000 cps.

A simple way to see the influence of elastic modulus on complex design equations like (5) and (6) in Table I is with the Ramberg-Osgood formula for the stress-strain curve, Eq (2). If the general power expression of the stress-strain curve is put into the dimensionless ratio form of (2), better comparisons can be made between materials, Fig. 1. By selecting the



3 Edge-loaded plate . . .

buckles if compression stress lies above these design curves. Shown here is effect of 15% reduction in elastic modulus for stainless W.



2 Compression . . .

stress-strain curve of stainless W gives Ramberg-Osgood constants by graphical construction.

base stress f_o as the stress at a secant modulus of $0.7E$, and the base strain $e_o = f_o/E$, all materials show the same initial slope and pass through the same point. Differences between materials are then shown by the shape of their curves, Fig. 1.

The slope, or first derivative, of this converted stress-strain curve is shown in Eq (3). Divided into modulus E, it forms the tangent ratio E/E_t and is a complicating factor in many buckling equations like (5) and (7). These two problems are simplified and design curves easily constructed as shown below.

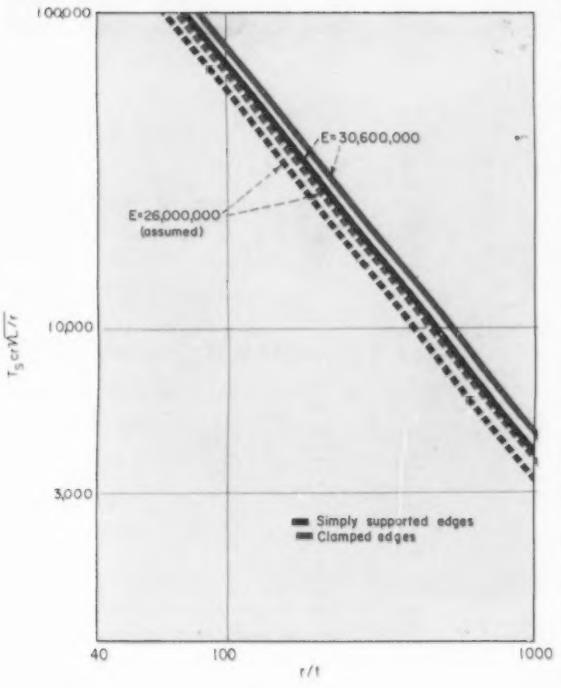
EDGE-LOADED PLATE

Since most design formulas are developed from the basic compressive stress-strain curve, first step in applying the Ramberg-Osgood technique is to obtain basic constants from the compression curve as shown in Fig. 2. The ratio E/E_t from Eq (4) is then inserted in the basic edge-loaded plate formula (5) giving (for $\mu = 0.35$) a buckling stress of

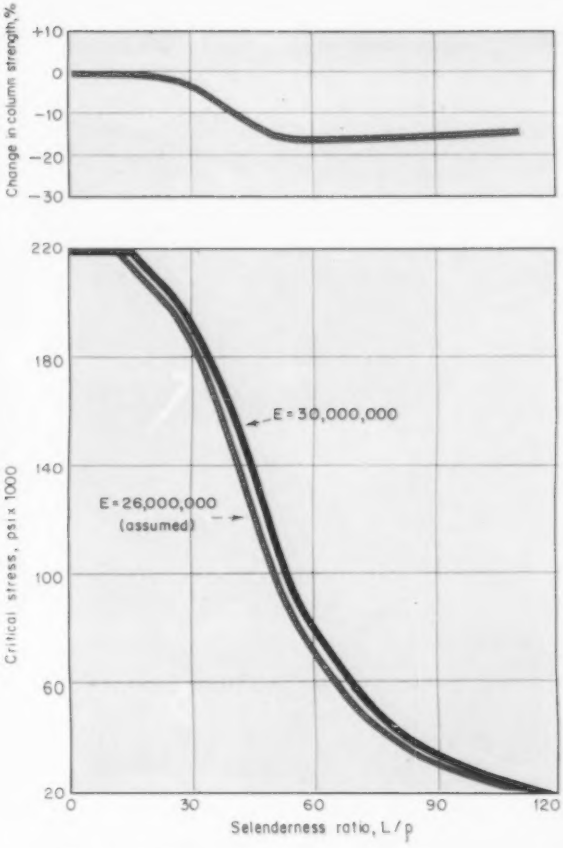
$$f_{cr} = \frac{0.937\,K\,E}{\left[1 + \frac{3\,n}{7}\left(\frac{f}{f_0}\right)^{n-1}\right]^{1/2}} \cdot \left(\frac{t}{b}\right)^2$$

By arbitrarily selecting a series of values for buckling stress $f_{cr} = f$, the design parameter $b/t(K)^{1/2}$ can be quickly computed. Plotting these gives a design curve, Fig. 3, which is the envelope of safe stress and safe proportions of the plate. Points above this curve are unsafe, though load may still be carried if slight buckling occurs.

To show influence of variations in the elastic modulus E, a critical stress curve for $E = 26 \times 10^6$ psi is also shown on Fig. 3. Except for the very high stress



4 Cylinder under torsion . . .
is also influenced by changes in modulus. These design curves show effect of 15% reduction in E for two types of edge-supports. Material is stainless W.



5 Simple column . . .
has reduced strength in elastic range when lower E values are used for stainless W, but loss is negligible in plastic range.

ranges, critical buckling stress is quite sensitive to modulus changes. In the 100,000-psi area, for example, a 15% change in E causes a 14% reduction in f_{cr}.

CYLINDER IN TORSION

Critical shear stresses in a cylinder under torsion, Eq (6) are affected by modulus changes in an easy-to-see manner. This equation is plotted in Fig. 4 for the same two E values, and for simply-supported and clamped edges. Variations with E are of about the same order of magnitude as for the edge-loaded plate, Fig. 3. Eq (6) is valid for tubes in the L/r range: $10(t/r)^{1/2} < L/r < 3(r/t)^{1/2}$.

COLUMN BUCKLING

A third problem, elastic instability of simple columns, is controlled by the tangent modulus E_t as shown in Eq (7). By eliminating E_t with the tangent modulus ratio, Eq (4), the critical compressive stress f_{cr} becomes

$$f_{cr} = \frac{\dfrac{\pi^2 E}{(L/\rho)^2}}{1 + \dfrac{3n}{7}\left(\dfrac{f}{f_0}\right)^{n-1}}$$

Using the Ramberg-Osgood constants, Fig. 2, with a series of selected values $f = f_{cr}$, limiting values L/ρ can be found and the column design curve, Fig. 5, plotted.

Following the same procedure with an E value 15% lower (using the same plastic behavior: $n = 22.5$), a percent difference in column strength f_{cr} is determined (color curve, Fig. 5). A 15% decrease in E gives a 15% drop in column strength in the elastic range, but in the plastic range (above 200,000 psi) the difference is negligible.

In actual practice, a 15% variation in E would not be realistic: either the test was inaccurately performed or the wrong specimen orientation was used. In either case, such a value would not be used in design.

EDITOR'S NOTE: Two recent articles that cover other aspects of thin-walled structures:

"Watch Out for Compression Loads," Dec 9 '57, p 72, explains differences between compression and tension properties of metals, particularly where creep is a problem.

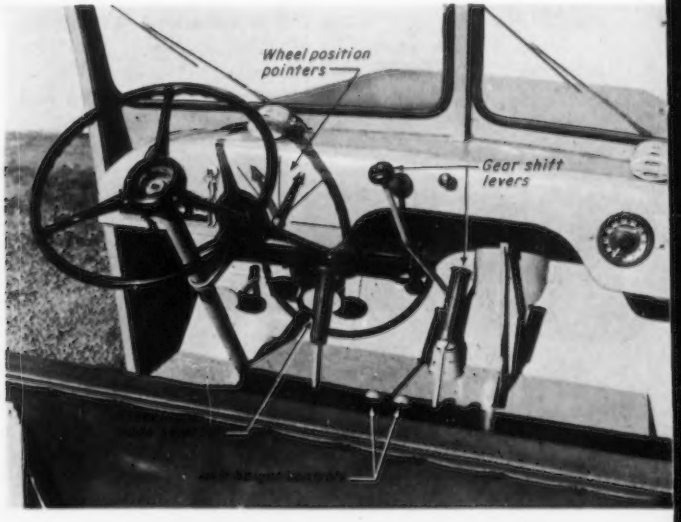
"Rapid Weight-strength Analysis of Pressure Vessels," Oct 14 '57, p 95, shows how to construct design charts based on simple weight-volume ratios for cylinders, spheres and elliptical heads.

DESIGN FEATURES

TRUCK

Great maneuverability . . .

and high drawbar power for operation on soft ground was designer's main objective. Construction is simple for low cost in small quantities. A 235-hp engine drives both sets of 12 wheels through a 5-speed transmission. Chain drives connect central axle of each group with outside axles, which are suspended on coil springs. A second transmission (forward, neutral, reverse) controls power flow to rear set of wheels. Hydraulic cylinders over central axles raise fifth wheels to lift outside axles when making sharp turns. Both wheel assemblies turn through 180°. Note coupling and universal between fifth wheel and differential.



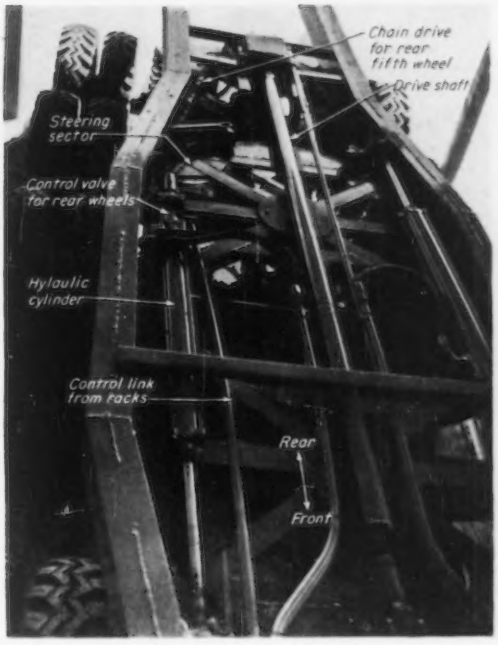
Controls in cab . . .

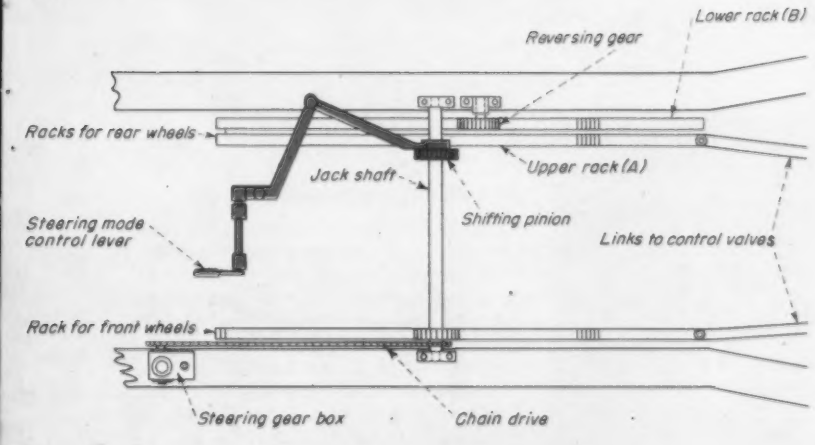
include pointers to indicate position of each set of wheels, steering-mode selection lever, two long levers to shift both transmissions, and two short levers to control raising and lowering of outside axles. Wheel-position pointers are driven by cables from fifth wheels. Each set of wheels has a separate brake pedal.

IN NEW PRODUCTS

GOES IN ANY DIRECTION

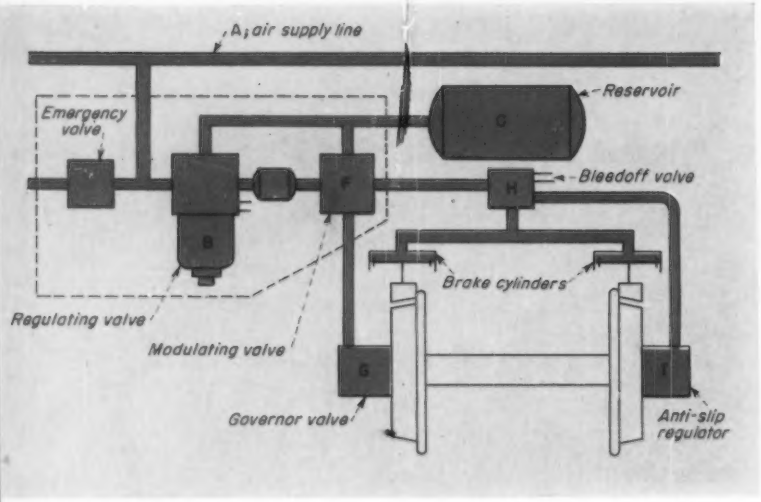
Off-the-road truck designed by E. M. Tucker, manager and chief engineer of the Tucker Sno-Cat Corp., Medford Ore., can be steered three ways: front wheels alone can be turned; front and rear wheels can rotate in opposite directions to turn truck within its length; and both sets of wheels can turn together to move truck sideways. All 24 wheels drive and brake. Potential applications include logging, construction, mining, airport services, and positioning military and industrial equipment. After it was built, the unusual vehicle became an orphan product; its owners are too busy to market it.





Steering flexibility is obtained . . .

by shifting pinion from one rack to another in controls of the hydraulically operated steering linkage. Pinion is on a jackshaft positioned by the steering gear through a chain drive and is shifted by a lever in cab. When pinion is disengaged from both racks in rear-wheel linkage, this set of wheels is locked in line with frame. If pinion is meshed with upper rack, A, drive to hydraulic control valve is direct. If it is meshed with gear that drives lower rack, B, drive to valve is reversed. A second pinion is always meshed with rack that controls front wheels.

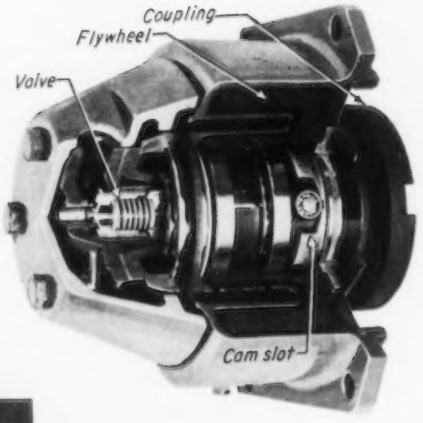


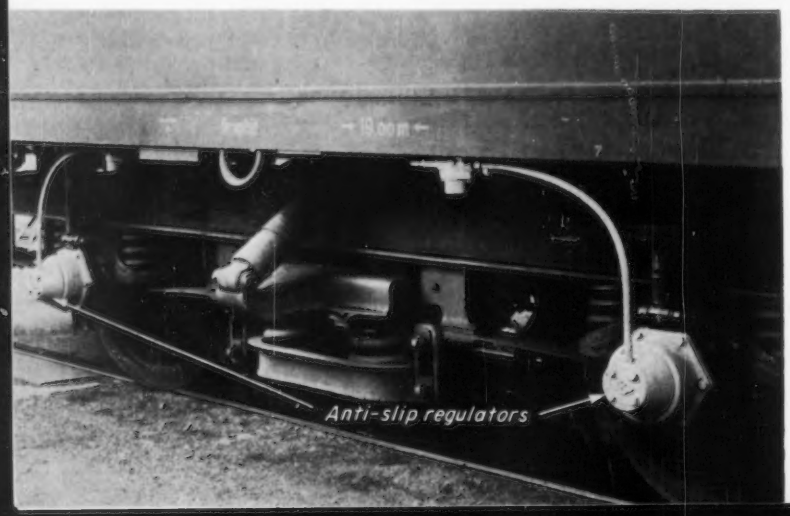
Air is supplied . . .

at 70 psi to regulating valve, B, in each car, through air line, A, while train travels at high speeds. This pressure charges reservoir, C. In other brake systems, the regulating valve admits compressed air directly from reservoir to braking cylinders when pressure in line, A, is reduced by engineman. With the system designed by Firma Knorr-Bremse GmbH, Munich, the air's pressure is modified further by a modulating valve, F, and bleedoff valves, H. Modulating valve varies air pressure supplied to brake cylinders of each car in response to speed signals from a centrifugal-governor valve, G, on one of its axles. Bleedoff valves for each brake cylinder are controlled by anti-slip regulators, I, on each axle. Governor valve admits high air pressure to brakes at speeds over 43 mph and low pressure below 30 mph.

Controlled Deceleration For Trains

For highest retardation rate possible with local track-friction conditions, braking of high-speed German trains is controlled by speed and wheel deceleration. A centrifugal governor for each car controls pressure of air supplied to brakes while anti-slip regulators on each axle bleed the brake cylinders to prevent wheel lock. With these devices, 93-mph trains are stopped in 3300 ft.



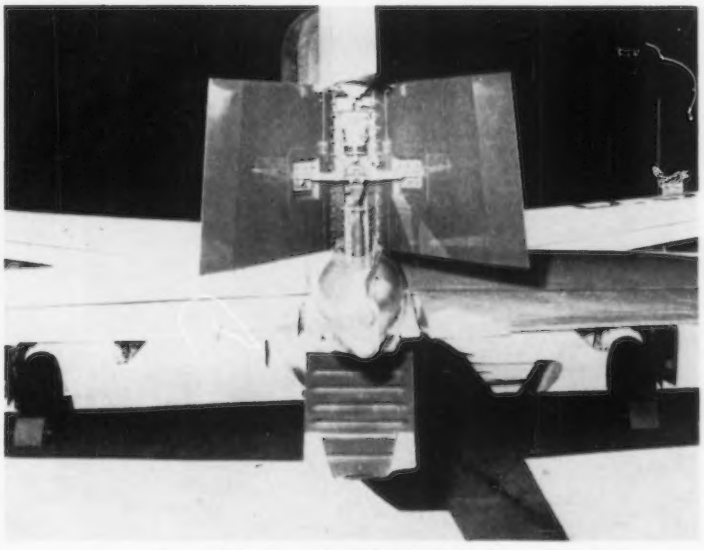


Anti-slip regulators . . .

consist of flywheel-actuated valves connected to each axle by a flexible coupling. When wheel deceleration is below 9.85 ft/sec², angular velocity of wheel and flywheel are equal. If train's wheel starts to lock, the flywheel's inertia moves it ahead of the wheel, and it is cammed axially to open a pilot valve. This causes the bleedoff valve to lower braking cylinder's air pressure until wheel stops skidding. Cam rollers are normally spring-centered in slot, which limits flywheel's motion.

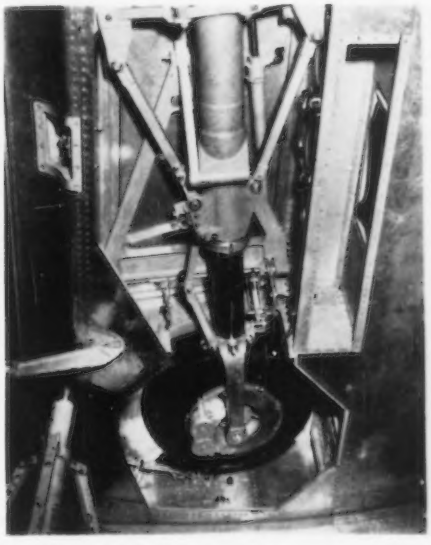
Evolution Follows Design of Jet Trainer

Continuous product development has made the production model of Temco Aircraft's jet primary trainer no more than a distant relative of its prototype. The Pinto's redesigned air brakes, trim tabs and landing-gear components give it better performance; bonded honeycomb construction in leading edge of wing simplifies construction.



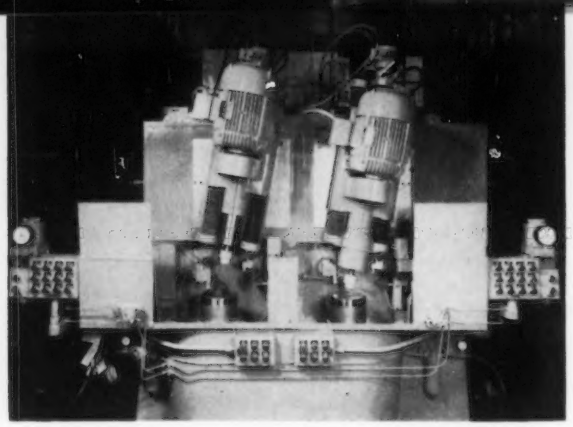
Speed brake has third panel . . .

opening downward below the fin's tail cone. Prototype had only the two-piece clamshell on the fin. Adding third panel corrected excessive pitch-up experienced when original brake was opened. With greater braking area, landing speed is lower, yet engine speed is higher. This makes extra power available if plane is waved off an unsafe landing. Tail flutter in the prototype was traced to a single high-aspect-ratio trim tab on the left elevator that was actuated on its outboard end. Production models have tabs with lower aspect ratios on both elevators. Reducing span and placing tabs inboard increased their torsional rigidity. A central linkage horn to actuate tabs eliminated play.



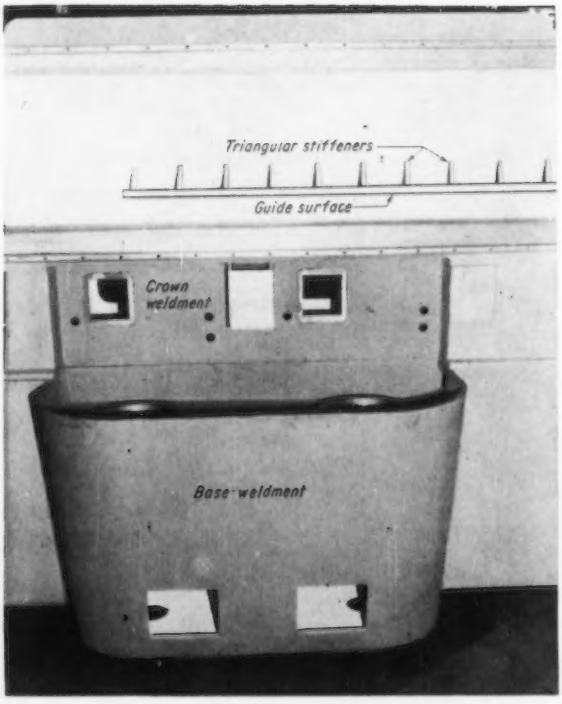
Landing gear is stronger . . .

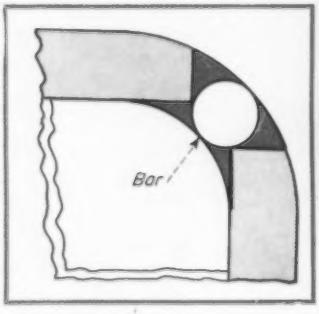
and has less drag. Shock-absorber stroke has been increased to allow a landing descent of 21 fps instead of the prototype's 18. Main gear components can now be interchanged by rotating the shock strut piston and reattaching radius rods to trunions on the opposite side. Disk brakes are now inside the wheels and provide greater braking force than the external brakes on prototype. For less drag at takeoff, main gear doors have been changed from 3-piece to a 2-piece construction and nose wheel doors are closed except when nose gear is raised or lowered.

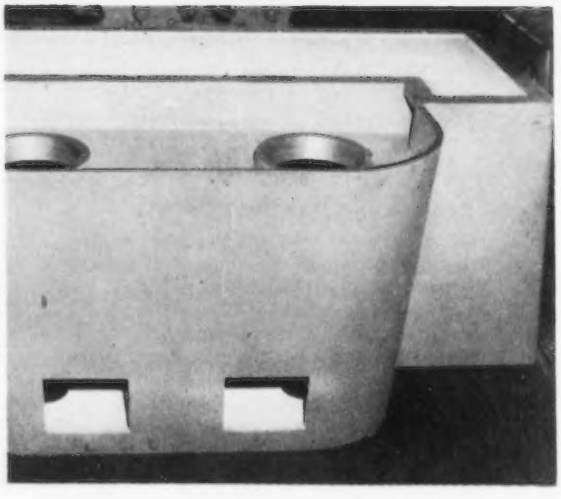


Weldments Make Low-cost, Rigid Frame

Vertical grinders made by Springfield Machine Tool Co., Springfield, Ohio, have welded rather than cast bases and crowns. Although the company has its own foundry, it finds weldments perform better than iron castings and cost less, principally because no patterns are needed and customer alterations are made easily.







Dual-head grinder . . .

has forward portion of base shaped to hold work stations. Although shape made base weldment inherently rigid, greater stiffness was obtained by adding internal stiffening plates. Frame is assembled by bolting crown weldment to base. Most weldments are ⅜-in. SAE-1020 hot-rolled plate. Horizontal plate on vertical face of crown is backed by triangular stiffeners on top. Its lower surface is machined to form the upper guide surface for a slide. All other stiffeners are inside the weldments and even the triangular guide stiffeners are hidden in the completed machine. Section through rear corner of base shows how fillets were welded around a ¾-in. bar. Details of this kind increase cost but increase rigidity and improve appearance too. Welds are made with Lincoln Electric Co. iron-powder electrodes.

12 ways to LOAD-TEST GEARS

Until a set of gears is fully loaded and subjected to dynamic conditions, its performance is only guesswork. Here are a dozen methods for testing the gears with locked-in torque.

Gene Shipley
Gear Engineering
General Electric Co., Lynn, Mass.

Gear analysis and design is no more than an educated guess—until the gear goes to work. The only way to be sure that a gear will perform as well as predicted is to test it under actual conditions of load and speed. It's then that wear life, fatigue life, frictional torque and dynamic stability can be noted and measured. The same is true for purchased gearboxes and transmissions, and for testing the effects of various lubricants on gear life.

But how to apply the load—or more specifically, the torque—to a set of gears waiting in the testing laboratory or on the production floor? It's not enough to couple them to a motor on one end and a mass with a certain inertia on the other—because once the gears are running at constant speed, the torque will drop to an amount only necessary to overcome friction. Also, there are many applications where the gears operate under high horsepower requirements, so high that it becomes impractical to simulate conditions by attaching a mass to the system.

The clue is in remembering that torque is proportional to twist. So twist the shafts in the gear system the desired amount. Next "lock in" the twist, so that the twist remains constant as the gear system rotates. Now attach a motor to the system and run it at desired speed for as long as you want.

There are 12 ways of applying full torque to a gear system. All are based on the "four-square" test setup in which two gear sets are joined back to back and locked together after applying a twisting couple to one of the connecting shafts. The 12 fall into one or the other of two main categories:

1. Methods in which torque can be applied to the gear system only when the gears are stationary. These methods, shown in Figs. 1 to 3, are simple and cheap, but require the gears to start up under full load. Many systems are not designed to do this.

2. Methods in which torque can be applied while the gears are running. Figs. 4 to 12. Here, loads can be remotely controlled and varied under realistic field conditions. In many cases they can be programmed. Another advantage is time-saving—loads can be changed without shutting down the machine. Also, there is less wear on the machine because loads can be applied when lubricating conditions are most suitable.

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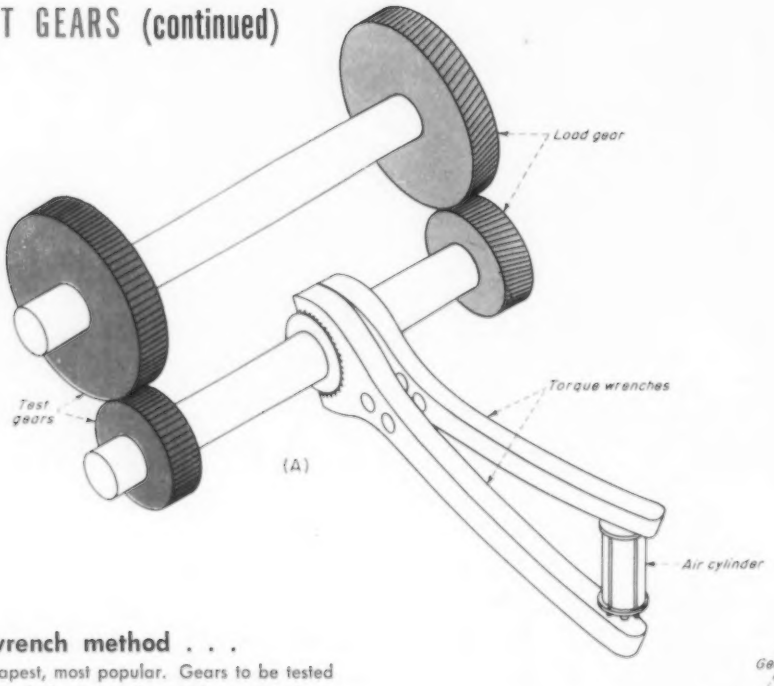
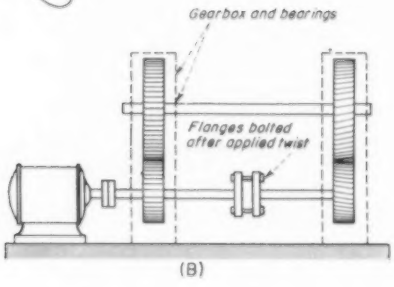
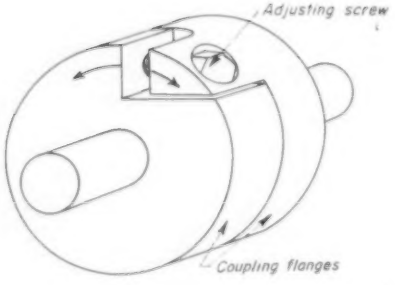
LOAD-TEST GEARS (continued)



1 Torque-wrench method . . .

is probably cheapest, most popular. Gears to be tested are mounted on shafts in tandem with a second set generally called "load gears" (bearings not shown). Lower shaft is in two sections. Air pressure to cylinder in (A) spreads apart wrenches which twist flanges in opposite directions and load the gears. Flanges are then bolted together (B), torque wrenches removed and system is motor-driven through its tests. Method can be used on production gearboxes as well as laboratory test gears. Main limitation: Gears must start up under full load.



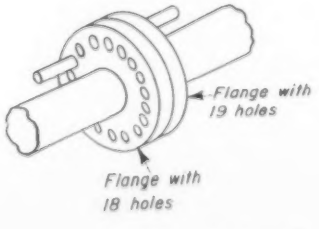


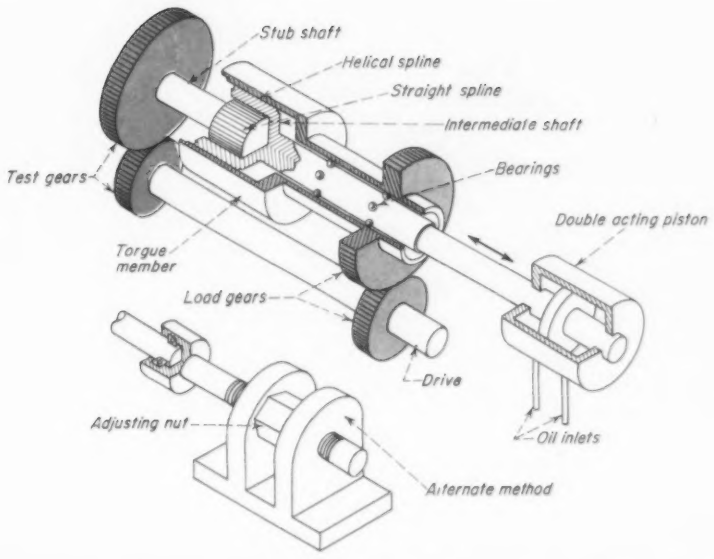
2 Screw coupling . . .

is adaptation of torque-wrench method. Turning adjusting screw displaces coupling flanges in opposite directions, applying torque to gear system. Locknut or screw with locking insert will prevent adjusting screw from loosening. System eliminates torque wrenches and air cylinder. Also, minute adjustments of torque are made easily. But gears must start up under full load.

3 Vernier coupling . . .

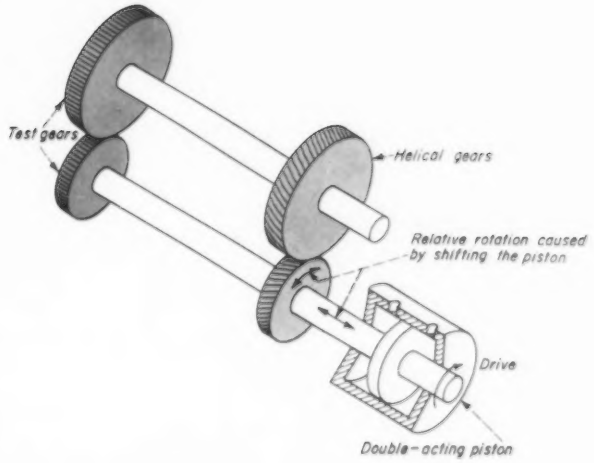
has two flanges with series of holes equally spaced around the outer edge. One flange has one more hole than the other. Additional hole functions as a vernier to permit fine adjustments in torque. Flanges are twisted by any method deemed best, and a pin inserted through appropriate set of holes.





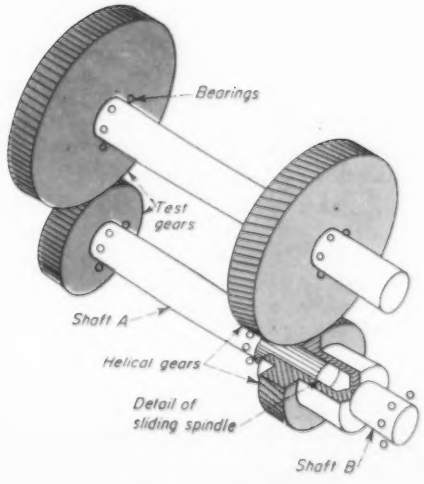
4 Spline coupling . . .

uses two spline systems to apply twist while shafts are rotating. Piston produces axial movement of the intermediate shaft, which has straight spline teeth on the ID and helical splines on the OD. This axial movement causes relative angular displacement between stub shaft and torque member. Piston pressure maintains twist as gears are driven through tests; its double action can apply torque in either direction to simulate a reversing system. Also, with a cam-driven control valve feeding pressure to the piston, the load can be controlled to simulate accelerating and decelerating conditions. A cheaper but less flexible way to apply load is to replace piston with an adjusting nut, as illustrated.



5 Helical gears . . .

mounted back-to-back with test gears provide test setup without need for additional couplings or mechanisms. When gears are stationary, helix angle allows applying a twist to the system by simply shifting the lower shaft axially either direction. The same torque will be applied if gears are running. Double-acting piston provides the shifting mechanism. Varying the pressure in piston will directly vary the torque-load on gears. Method is not practical for testing production gear-boxes. Helical-gear box and piston can be mounted on a permanent base. Wide pinion gears are used on both the helical and spur gears when possible.

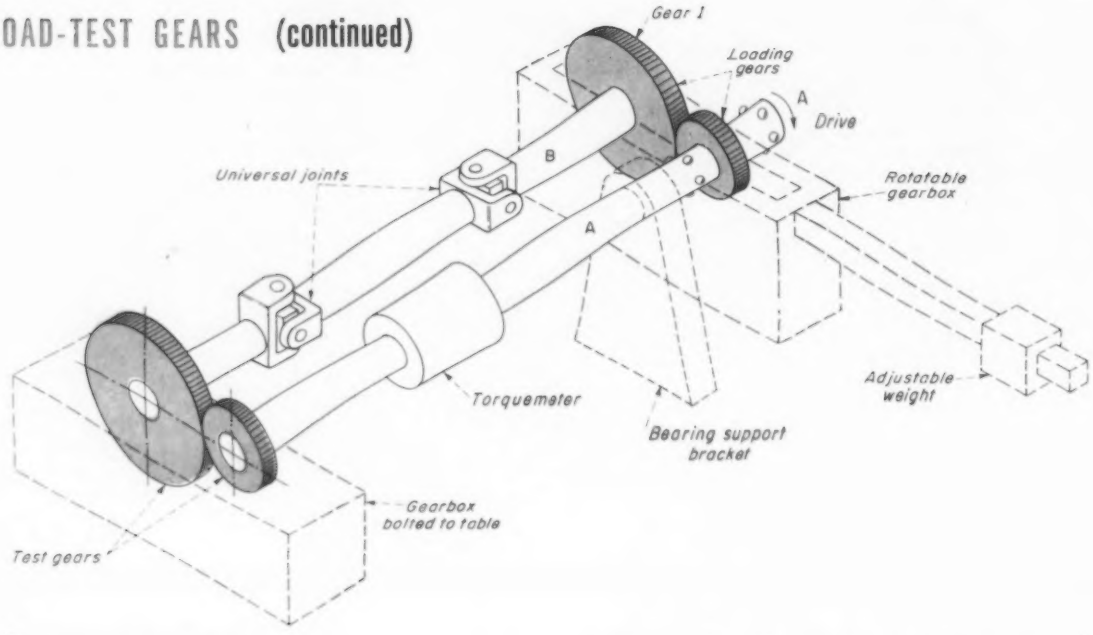


6 Sliding spline . . .

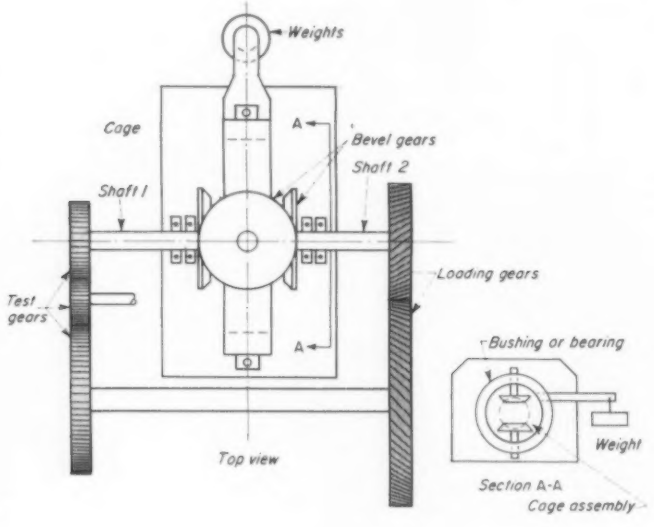
uses principle of moving a helical gear axially to produce desired torque. Spline couples two shafts A and B. Shifting helical pinion gear will not shift test gears. The lower helical gear has extra-wide face width for continual contact during shifting. Because all the mechanisms are confined to one gear-box, this system is often employed to test production gears.

(continued on next page)

LOAD-TEST GEARS (continued)

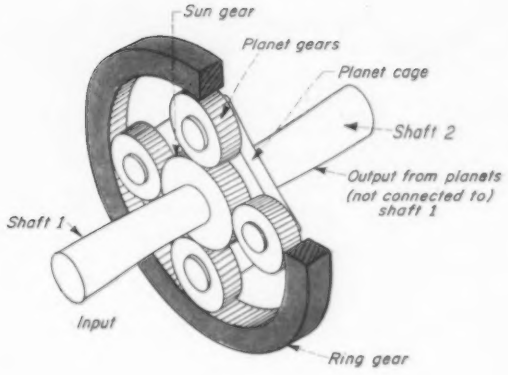


7 Rotating gearbox . . . is free to turn about axis A-A. Test gearbox on other end is bolted to base plate or table. The boxes contain bearings for mounting the shafts. When box is rotated slightly by extending adjustable weight, gear 1 will creep over gear 2, causing angular displacement in shaft B which opposes normal rotation of the system and gives torque in the shafts. The universal joints in shaft B take up misalignment caused by relative displacement. Misalignment limits the load and speed capacity, but system is reliable, all-mechanical, easy to operate. Torque can be accurately varied by minute adjustments of weight. A torquemeter gives quick readings.



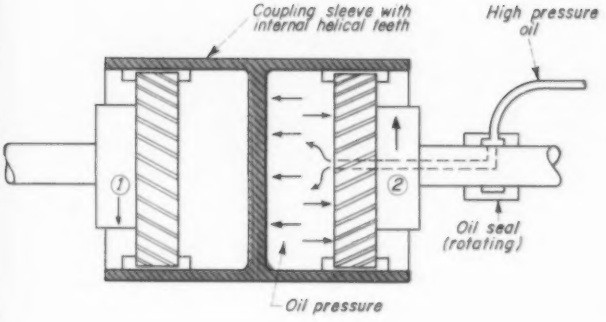
8 Bevel-gear differential . . . applies torque simply by adding weight to the loading arm which rotates cage assembly. To assure alignment, cage is mounted in a bushing or bearing, as illustrated in section A-A.

Because shafts 1 and 2 will rotate in opposite directions, an idler is employed in the test-gear train to reverse direction—an advantage when the gearbox under test has a 3-gear spur or helical system. The full-load torque is limited by capacity of the bevel gears because it must be transmitted through the differential. Bevel gears are usually made as large as possible.



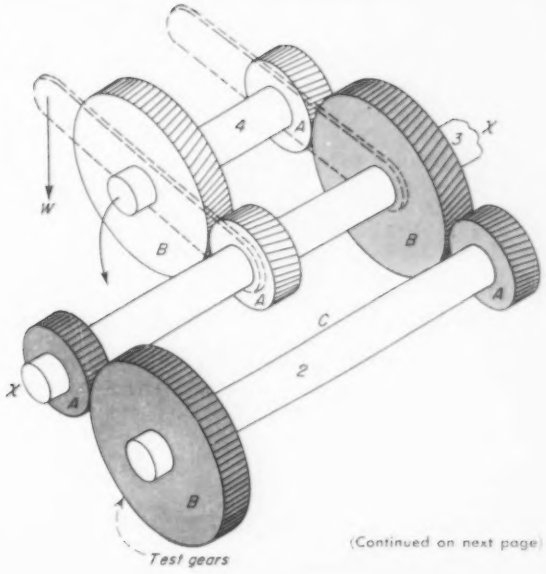
9 Planetary torque applier . . .

is similar to (8): Shaft 1 is connected to test gears and shaft 2 to loading gears. There is a constant ratio between shafts 1 and 2 as long as ring gear is stationary. Rotating it introduces relative twist between shafts. Ring gear can be accurately adjusted to give desired torque. Shaft 2 will rotate at slightly reduced speed relative to shaft 1, but in same direction.



10 Double helical sleeve . . .

operated by oil pressure which forces apart the sleeve and one of the gears. This causes a relative twist between shafts as indicated by arrows 1 and 2. Second chamber is ported to atmosphere; however, oil can be pumped in from shaft on left to convert sleeve into a double-acting piston. Method produces a wide range of torques, has given successful tests with systems up to 100,000 hp.

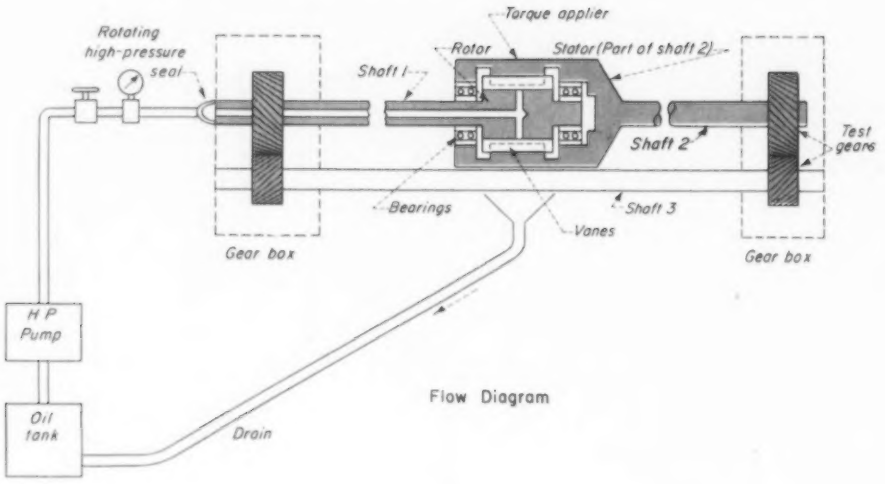


11 Multiple-shaft system . . .

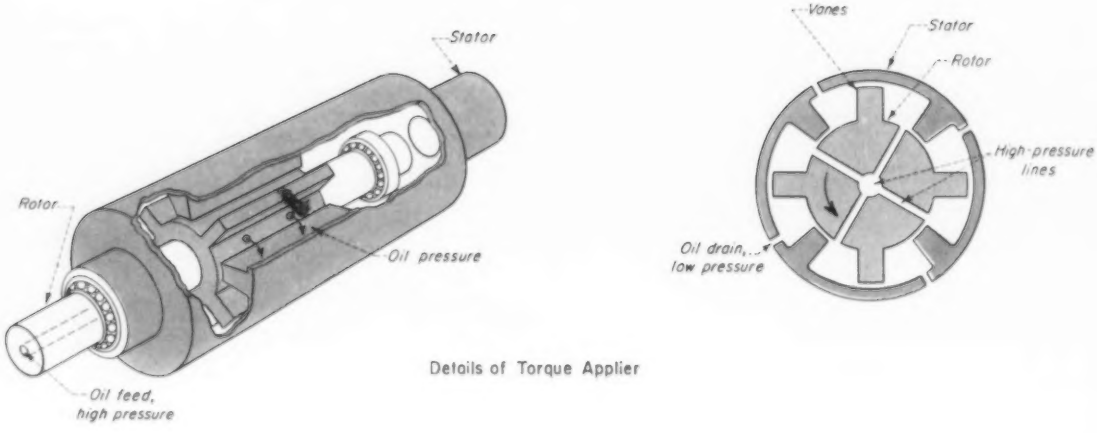
applies torque to test gears by shifting shaft 4 around axis X-X. All gears marked A are same size; similarly for gears marked B. Twisting moment is controlled by adjusting weights on lever arm. System is usually limited to testing only one size of gears. All except test gears can be assembled in one loading box.

(Continued on next page)

LOAD-TEST GEARS (concluded)



Flow Diagram



Details of Torque Applier

12 Hydraulic torque applier . . . uses water-wheel principle to create relative twist between shafts 1 and 2. A high-pressure vane pushes oil through rotating shaft and out between vanes of rotor and stator. The oil forces vanes apart, causing a twist in shafts similar to a torque-wrench twist. Oil leakage to low-pressure side is bled off through holes in periphery. Oil pressure is easily adjusted to give wide range of loads. Method is ideally suited for testing production units because it works satisfactorily with a wide range of speeds and horsepowers.

Editor's Note: The emphasis on precision and reliability has led to these new concepts in specifying gears:

"7 Rules Simplify Instrument Gear Specifications," Nov 25 '57, p 80. Specifying too many requirements is time-consuming and expensive. This article boils specifications down to a minimum.

"Profile Diagrams—A Graphical Way to Specify Gear Errors," Oct 14 '57, p 86. Tips on tooth-profile tolerances and how to use them.

"Tolerances for Over-pin Gear Measurement," May '57, p 194. How to convert AGMA specifications for backlash and tooth-to-tooth composite errors to tolerances for over-pin measurements.

"Methods for Specifying Precision of Spur Gears," Nov '56, p 135. Analysis of AGMA and modified AGMA methods for determining accuracy by rotating the gear with a master gear. Other recent articles on gear drives include: "Gear-shift Arrangements," Apr '57, p 188, 13 ways of arranging gears and clutches to obtain changes in speed ratios; "Chatter in Gear Drives," Dec '56, p 168, Chatter analysis by instrument, and equations for computing speed variations.

DOW CORNING CORPORATION

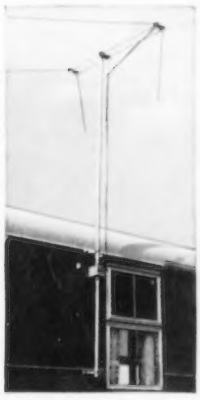
Silicone News

FOR DESIGN ENGINEERS No. 46

LUBRICATE, PROTECT RUBBER WITH SILICONE COMPOUND

More evidence that silicones add to the efficiency and practicability of a design at negligible extra cost is provided by the rotating TV antenna produced by Braund Manufacturing Company, Battle Creek, Michigan.

The Braund TV Selector Tower is a manually-operated, gear-driven antenna especially designed for use with mobile homes. Located outdoors where they are exposed to weathering, the gear box and retaining brackets are sealed with neoprene bushings which require permanent lubrication to assure easy, smooth, quiet operation in any weather.



Braund tested various organic greases in search of a suitable all-weather lubricant. All of them, however, either caked up or washed away within a few weeks. Finally, the problem was solved by switching to semi-inorganic Dow Corning 7 Compound.

An excellent lubricant and preservative for moving rubber parts, Dow Corning 7 Compound effectively lubricates the antenna

(Cont. Pg. 2)

SEARS ROEBUCK SPECIFIES SILASTIC FOR DURABLE, HEAT RESISTANT GASKETS

Designers of appliances count on Silastic*, the Dow Corning silicone rubber, to solve even the "hottest" gasketing problems and assure long maintenance-free service. A case in point is the rotisserie door gasket featured on the Kenmore range sold by Sears, Roebuck and Company.

When the Kenmore rotisserie is used as a broiler, its door is left open exposing the gasket to temperatures up to 500 F — heat that would quickly destroy the effectiveness of an organic rubber gasket.

The Silastic gasket, however, stays flexible —will not harden or crack—in spite of repeated exposure to elevated temperatures. The gasket retains its original shape, prevents heat loss and provides a desirable cushioned sound when the door is closed.

Sears specified Silastic for the door gaskets when the rotisserie was designed two years ago. The company has yet to receive its first complaint of unsatisfactory service.

*T. M. REG. U. S. PAT. OFF. No. 467

SILICONES PROTECT BEAUTY OF FOIL PLASTIC TRIMS

By making imaginative use of a silicone emulsion, Anchor Plastics Company of Long Island City, New York, has found a practical way to protect the original beauty of "Plastic-Krome" trim.

Polished metal foil imbedded in extruded plastic shapes gives Plastic-Krome trim the sparkle of chromium, gold or copper. Designers like the trim's eye-catching gloss and reflectivity in combination with plastic's economy and serviceability.

For over two years, Anchor Plastics has finished the extrusions with a wipe-on coating of dilute Dow Corning 36 Emulsion. Anchor engineers assert the dry silicone film protects the plastic against marring and scratching, especially important when the trim is shipped in bulk. Moreover, the invisible silicone coating increases the trim's original sparkle.

The hardy silicone film withstands heat and cold, and repels water. Its wetting and spreading characteristics permit easy application of a smooth, continuous, non-oily film. No. 466

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

NEW LITERATURE AND TECHNICAL DATA ON SILICONES

Now Available — 1958 Guide to Dow Corning Silicones gives properties and uses for the silicone products available in commercial quantities. Its 16 illustrated pages suggest numerous ways you can cut costs, simplify designs, improve performance and add new sales appeal to products by making imaginative use of these new engineering materials. *No. 470*

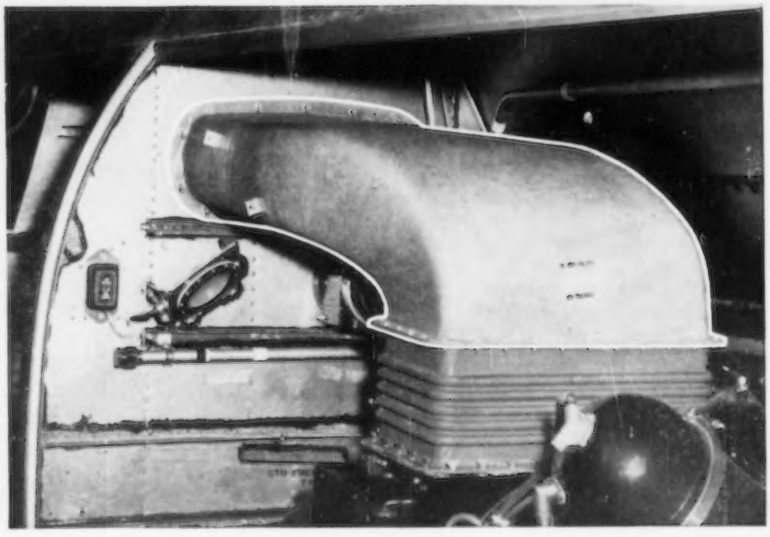
Dow Corning Silicone Lubricants, including oils and greases, are described in an illustrated 8-page brochure that gives their properties, lists their applications, and cites factors which contribute to obtaining longer life. *No. 471*

Protective Finishes and Maintenance Paints, made with Dow Corning Silicones, are available from more than 50 formulators listed in a 4-page brochure that describes how these heat, moisture, and oxidation resistant coatings improve product finishing, and reduce maintenance costs. *No. 472*

New Silicone Coating for paper and paperboard keeps gummy and tacky materials from sticking to all types of bags, boxes, inner liners, wraps and interleaving sheets. Will not migrate; will not contaminate materials that come in contact with it. New brochure containing sample papers describes how Silicone Coating aids packagers and processors of sticky products. *No. 473*

Silicones as Dielectrics. Just published. A 12-page, fact-filled must for design engineers. It's a convenient selection guide to the silicone dielectrics most adaptable to particular applications that range from electronic components and assemblies to power distribution equipment and motors. *No. 474*

Silastic RTV vulcanizes at room temperature. It provides a means of using silicone rubber in those applications where a heat cure is impractical or cannot be tolerated. Available in different consistency grades, Silastic RTV retains good physical and dielectric properties. *No. 475*



MAKE BETTER HOT AIR DUCTS WITH SILICONE-GLASS LAMINATES

Silicone-glass structural laminates are now becoming almost common place, especially on aircraft. Lighter, and easier to fabricate than stainless steel, silicone-glass laminates retain a higher strength-to-weight ratio at elevated temperatures than many light metals.

Douglas Aircraft's Long Beach Division, for example, has made excellent use of these new heat-resistant structural materials for hot air ducting on their C-133A. Among other advantages, Douglas cites the following reasons for switching to silicone-glass laminated structures—

1. Outstanding heat resistance. Silicone-glass laminates are the only plastic structures that can withstand their flame test — 15 minutes at 2000 F— without flame penetration.
2. Low cost fabrication. Forming silicone-glass structures on plaster break-away molds is much cheaper than drawing stainless steel, especially with complex configurations.
3. Weight savings. While specific application data are confidential, silicone laminates are considerably lighter than stainless steel.
4. Glass fibers bonded with Dow Corning silicone resins retain greater strength-to-weight ratio at high temperatures than metals. *No. 469*

RUBBER PRESERVATIVE *(Continued)*

mechanism over a broad temperature span, more than meets all weather requirements and lasts indefinitely. Thousands of silicone lubricated Braund units are in use all over the North American continent without a single complaint to date. Furthermore, the company now plans to use the silicone compound on larger antenna units for conventional homes.

What about cost? "The expense of Dow Corning 7 Compound per unit is so small, we don't even include it in our cost breakdown," writes C. L. Braund, "but we couldn't operate our mechanism without it." *No. 468*

Dow Corning Corporation, Dept. 861, Midland, Michigan

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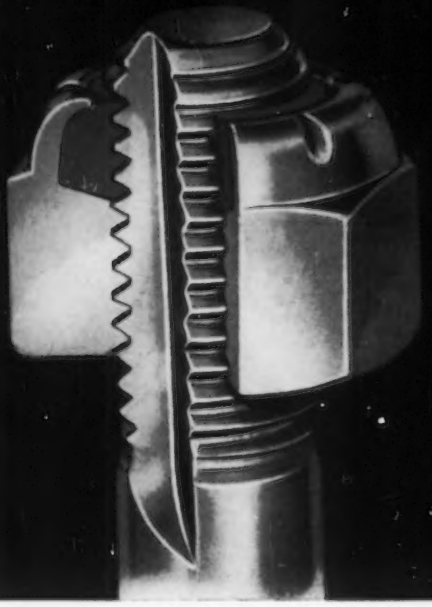
The nylon collared Elastic Stop* nut never damages bolt threads!



The nylon locking insert * will not seize threads, gall or remove plating

The red nylon locking collar is an integral part of an Elastic Stop nut. Undersize in diameter in relation to standard bolt tolerances, this insert grips the entering bolt threads with strong, smooth nylon fingers that dampen impact loads and resist turning under the most severe conditions of vibration or shock. The perfect fit between bolt threads and the locking collar also serves to seal off internal bolt and nut threads and to protect them against corrosion. Furthermore the nylon insert is impervious to gasolines, oils, salt atmospheres, cleaning compounds and common acids. The remarkable wear resistance of nylon plus its elastic recovery makes Elastic Stop nuts reusable through more than a hundred on and off cycles.

Because an Elastic Stop nut is a one-piece unit it is less expensive to install than castellated nuts and cotter pins, or double nuts. Equally important, it is a *stop* nut that *locks at any position on the bolt* without requiring secondary "safety" devices; it is simple to adjust precisely—it is easily wrenched off or readjusted. Elastic Stop nuts have been used by American industry since 1930 to solve the toughest applications on railroad, automotive, earth moving and farm equipment, as well as on all types of electrical machinery.

Elastic Stop nuts are available in sizes ranging from a watchmaker's 0-80 through 3", and in many standard finishes and materials including carbon and stainless steels, brass, duronze and aluminum.

ELASTIC STOP NUT CORPORATION OF AMERICA

also maker of the **ROLLPIN** TRADEMARK

*The Red Locking Collar is a Registered Trademark of ESNA

Elastic Stop Nut Corporation of America
Dept. N27-112, 2330 Vauxhall Road, Union, N. J.

Please send me the following free fastening information:

☐ ELASTIC STOP nut bulletin

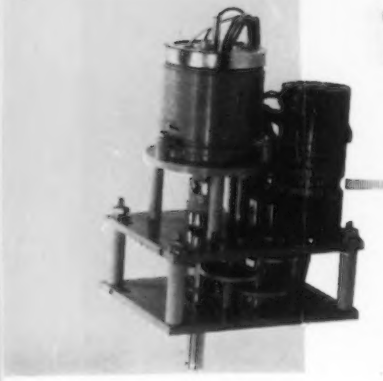
☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____

Company_____

Street_____

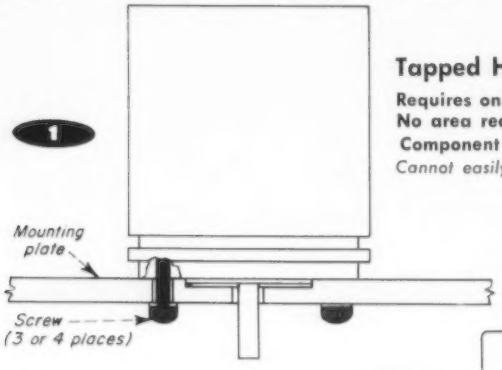
City_____ Zone____ State_____



10 ways to MOUNT SERVO

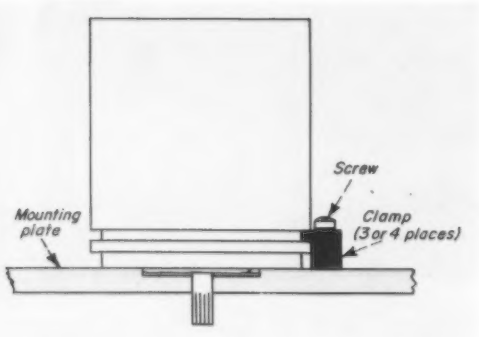
with their advantages and disadvantages

Advantages are in boldface *Disadvantages* are in *italics*



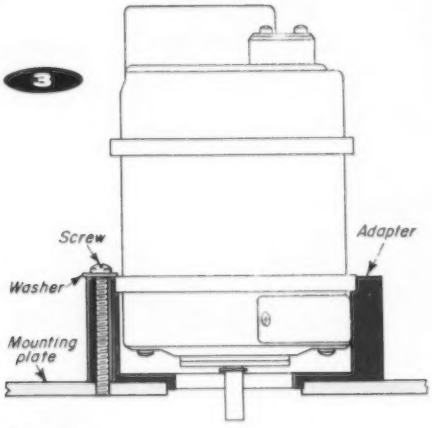
Tapped Holes In Component

Requires only screw clearance holes in plate.
No area required beyond dia of component.
Component can be rotated for phasing.
Cannot easily be removed for replacement.



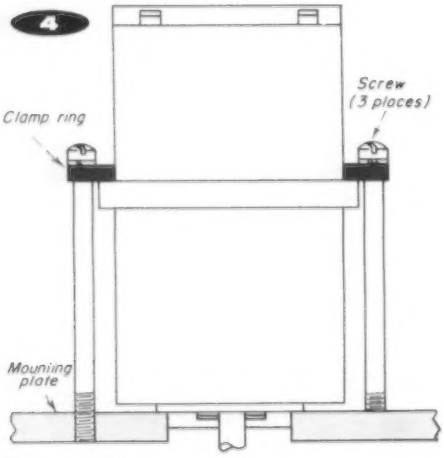
Clamps

Component can be rotated for phasing.
Can be easily removed.
Additional parts to handle.
Tapped holes required in plate.
Clamps occupy additional plate area.



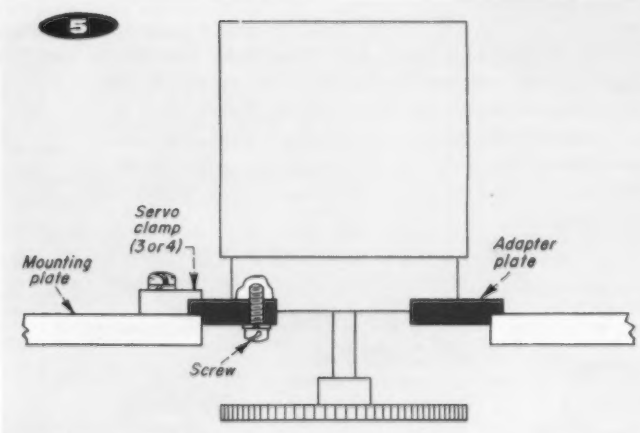
Adapter

Component can be removed without disturbing gear train.
Cost of adapter.
Additional depth required.



Clamp Ring

Component can be rotated for phasing.
Inexpensive part to manufacture.
Occupies additional plate area.



Adapter Plate

Allows phasing and easy removal of component, which is mounted to adapter plate by screws as in first method.
Cost of additional parts.

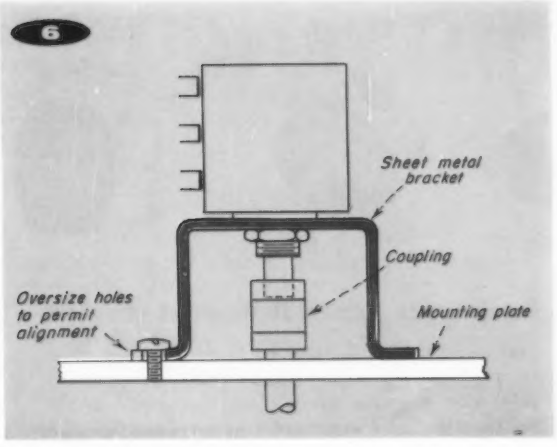
COMPONENTS

FRANK W. WOOD, JR.
Design Engineer Servonics Inc., Va.

Product Engineering

DESIGN ROUNDUP...

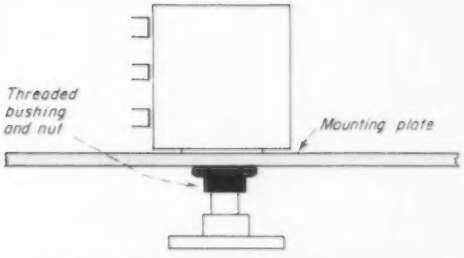
6



Sheet Metal Bracket

Inexpensive to fabricate.
Allows mounting of components that do not have conventional servo mount.
Because of sheet metal tolerances, unit must be aligned at final assembly.

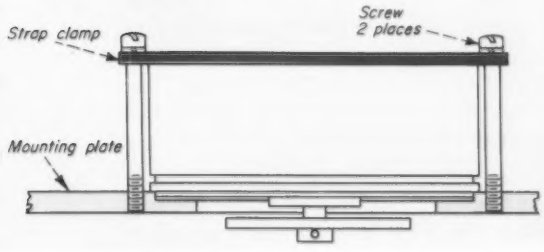
7



Threaded Bushing on Component

No adapter or servo clamps required.
Allows mounting of component that does not have servo mount.
Component cannot be easily phased.
Component cannot be easily removed.

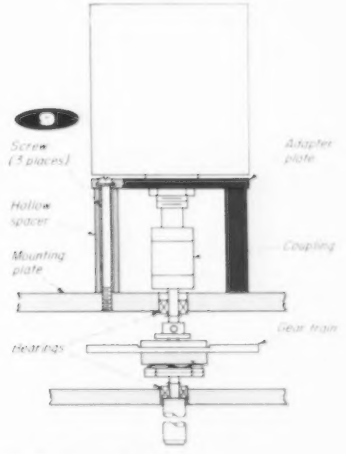
8



Strap Clamp

Inexpensive to produce.
Allows phasing.
Occupies additional plate area.

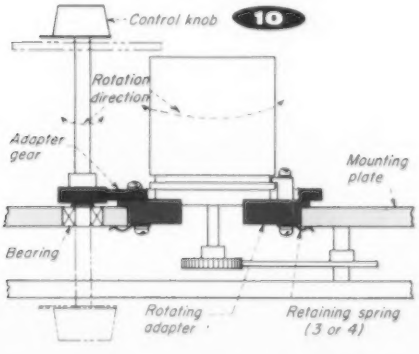
9



Adapter Plate on Spacers

Allows mounting of components that could not otherwise be mounted to gear train by providing space for flexible coupling between component bearing and external bearings.
Additional depth required.

10



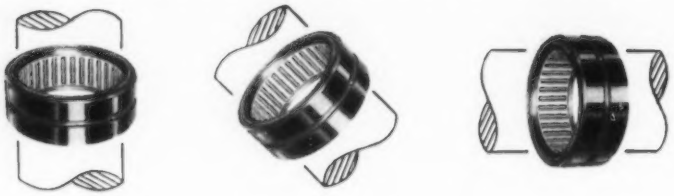
Rotating Adapter

Allows remote phasing of component from front panel.
Cost of extra mounting parts.

ORANGE *Cage Type* NEEDLE BEARINGS

are true running in any position

VERTICAL . . . . TILTED . . . . . HORIZONTAL



Cage assures permanent alignment of rollers

Each needle roller is retained in pockets of a cage made of anti-friction, non-ferrous metal. These pockets guide and align the rollers along their entire length. The cage does not wear on the rollers, since the cage land rides on the outer race. Square end rollers provide maximum effective roller length.

The Rollers Roll evenly — never Skew or Slide

The non-skewing, aligned roller action of Orange Cage Type Needle Bearings adds many additional advantages to the high-load, small-space characteristics of conventional needle bearings.

For example: Less internal friction—quieter running—meet higher precision requirements—operate at higher speeds—may be used on overhung mountings—less affected by misaligned mountings or uneven loading—longer life expectancy.

Orange Cage Type Needle Bearings are available in stock sizes from ½" to 8" dia., interchangeable with all standard needle bearings. Write for Engineering Manual M-56.

Kingsbury Machine Tool Corp. uses Orange Cage Type Needle Bearings to align the vertical spindles in the drill heads of Kingsbury Indexing Automatics, to meet small space and precision operating requirements.

WRITE for 40-page Engineering Manual showing construction, dimensions, capacities of all Orange Roller Bearings.

ORANGE ROLLER BEARINGS

ORANGE ROLLER BEARING CO., Inc.
551 Main Street, Orange, N. J.

Needle Bearings — Staggered Roller Bearings
Journal Roller Bearings — Thrust Roller Bearings
Cam Followers

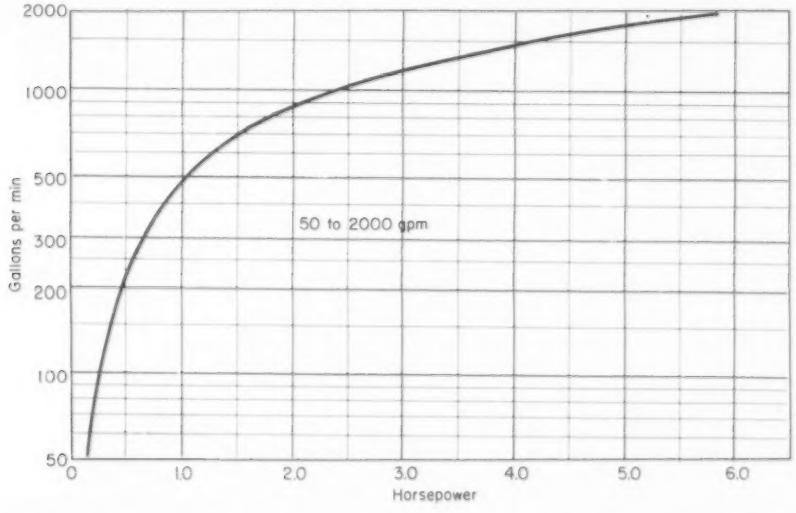
how much HORSEPOWER to pipe liquids?

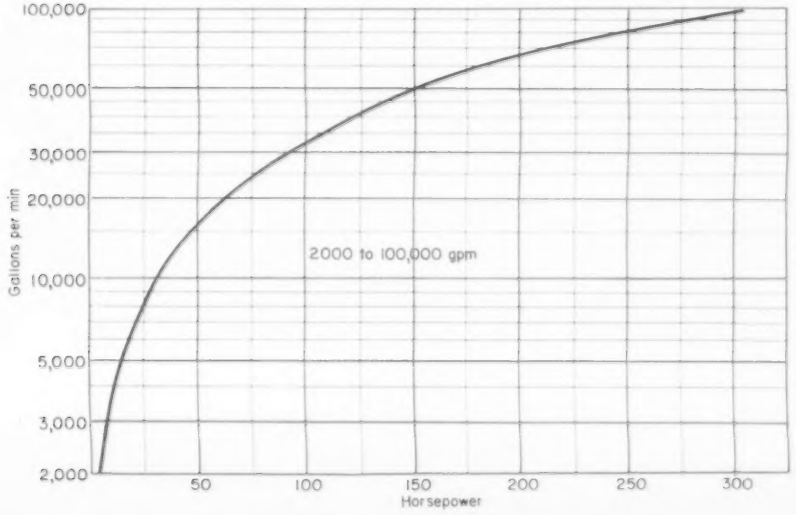
Charts give answers for flow from 50 to 100,000 gpm for pipe-roughness ratios of 0.02 to smooth.

The charts on these two pages will make it easier to design pumps and other equipment for handling liquid flowing in pipes.

First, it is often helpful to know the theoretical horsepower required to raise the liquid to various heads. This is obtained from the horsepower-gpm charts. They are plotted for a 10-ft head of water: For other heads, multiply hp by $H/10$ where H is the revised head; for other liquids, multiply by the corresponding specific gravity.

(Continued on page 91)



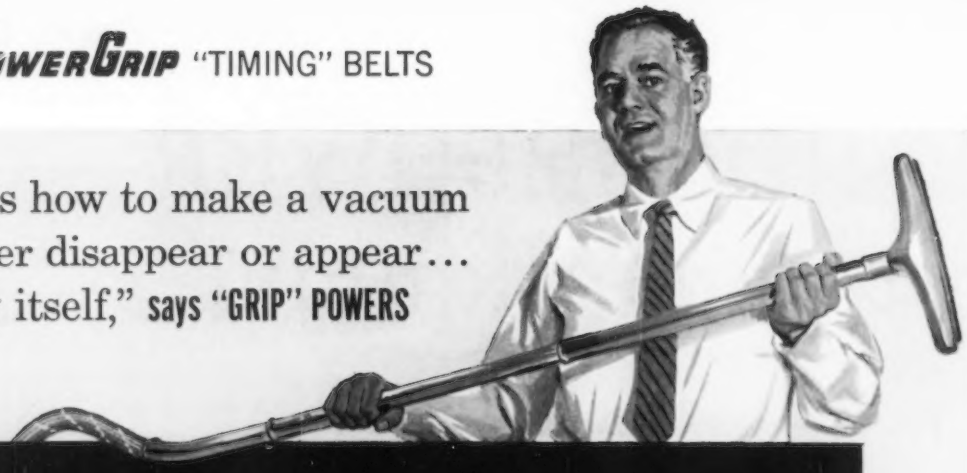


Hp-gpm Chart . . .

shows how much hp is required to pump water against a 10-ft head. Full-pipe flow is assumed.

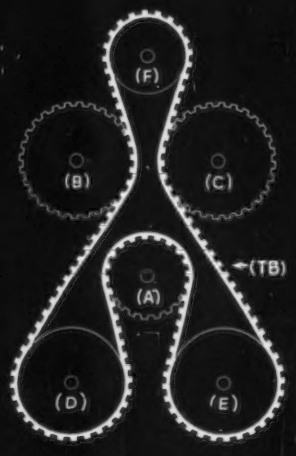
US RUBBER **PowerGrip** "TIMING" BELTS

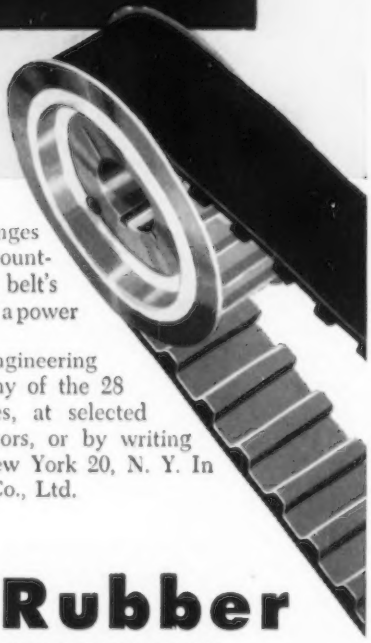
"Here's how to make a vacuum cleaner disappear or appear... all by itself," says "GRIP" POWERS



In this schematic of the hose retraction and extension mechanism of the EasyWay Vacuum Cleaner,* the 12-groove drive pulley (A) is powered by a ¼ h.p., 1750 r.p.m. electric motor. The power is transmitted—*through a single U.S. PowerGrip "Timing" Belt (T-B)*—to four pulleys. Two of these (B & C) are 26-groove "Timing" Belt pulleys which are positively engaged by the teeth of the belt. The other two (D & E) are flat pulleys, which are driven by the friction surface on the back of the belt. A small flat belt pulley idler (F) provides adjustment and more wrap around the four driven pulleys. These four pulleys, in turn, drive four specially molded U.S. Rubber rollers located on the other side of the plate. The rollers, by rotating, drive the hose (also made by U.S. Rubber) either in or out, as required.

*Manufactured by Simplon Corp., Dearborn, Mich.





"Grip" Powers is holding the "business end" of one of the most modern home appliances—a vacuum cleaner, built into the wall, with hose that extends or retracts *completely automatically.*

This cleaner can literally "put itself away," thanks to the U.S. PowerGrip "Timing"® Belt drive on the hose retraction mechanism (pictured above.) Because of PowerGrip's near-100% efficiency, the manufacturer was able to combine simplicity of design with exact response to constant changes in tension. This is just one of countless examples of this unique belt's ability to simplify and improve a power transmission unit.

These belts, plus expert engineering service, are obtainable at any of the 28 "U.S." District Sales Offices, at selected power transmission distributors, or by writing us at Rockefeller Center, New York 20, N. Y. In Canada, Dominion Rubber Co., Ltd.

US RUBBER **Mechanical Goods Division**

United States Rubber

See things you never saw before. Visit U.S. Rubber's new Exhibit Hall, Rockefeller Center, N.Y.

how much HORSEPOWER to pipe liquids (continued)

SYMBOLS

G = flow rate, gpm	R = Reynold's number $= 0.0833\,Vd/\nu$	w = fluid density, lb per cu ft
H_1 = head loss, ft	V = velocity, fps	r = relative roughness of pipe $= \epsilon/d$
L = length of pipe, ft	d = pipe dia, in.	ϵ = effective height of roughness particle, in.
P = pressure, psi	f = friction factor	ν = kinematic viscosity, ft²/sec

Next, for practical results friction losses must be accounted for. These vary and should be known for each individual case.

Much used in liquid-flow calculations is the Darcy formula

$$H_1 = f\,\frac{6LV^2}{d32.16}$$

which can be modified, if velocity is in gpm, to

$$H_1 = 0.0312f\,\frac{LG^2}{d^5}\,w$$

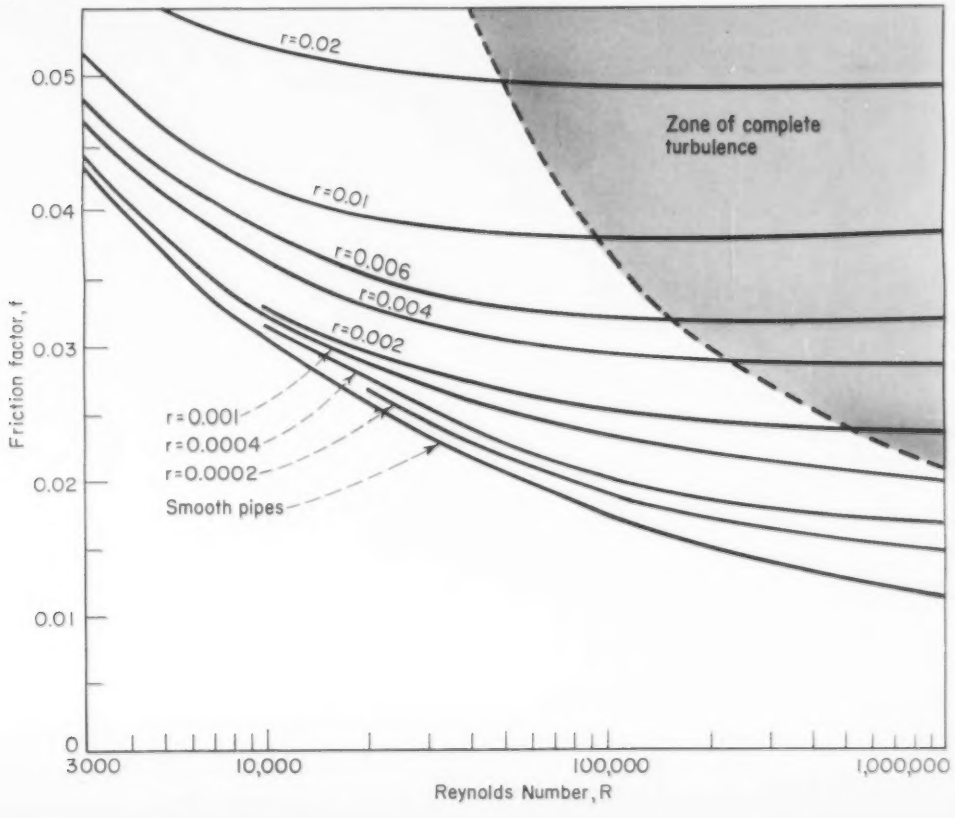
or for head loss in psi units

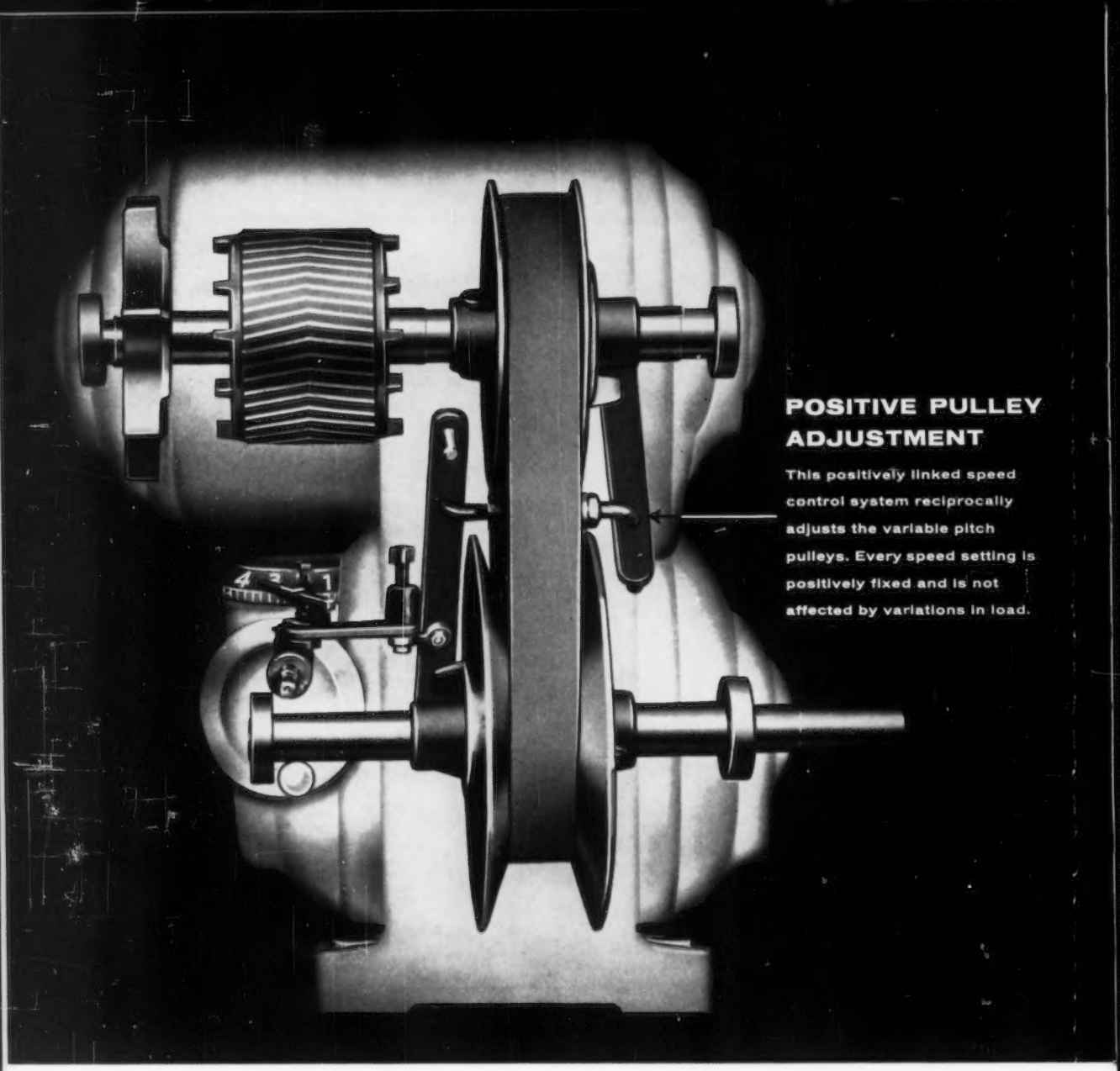
$$P = 0.000217f\,\frac{LG^2}{d^5}\,w$$

Practical values of f vary from about 0.01 to 0.06 depending on pipe smoothness and dia. For laminar flow, $f = 64.4/R$. The flow chart gives f for various values of R and pipe roughness. Values ϵ for various pipes are: 0.00006 in. for smooth drawn tubing; 0.0018 in. for wrought iron; 0.01 in. for cast iron. Curves for relative roughness values of 0.0005 to 0.01 are plotted. Most of these lie in the transition zone between laminar flow and complete turbulence.

Fluid-flow Chart . . .

gives friction for various pipe conditions and values of Reynold's Number.




POSITIVE PULLEY ADJUSTMENT
This positively linked speed control system reciprocally adjusts the variable pitch pulleys. Every speed setting is positively fixed and is not affected by variations in load.

New Worthington motor drive gives you

ACCURATE SPEED REGARDLESS OF LOAD

Once you set the speed on a Worthington variable speed motor drive, the pulley holds it – maintaining accurate speed control regardless of variations in load.

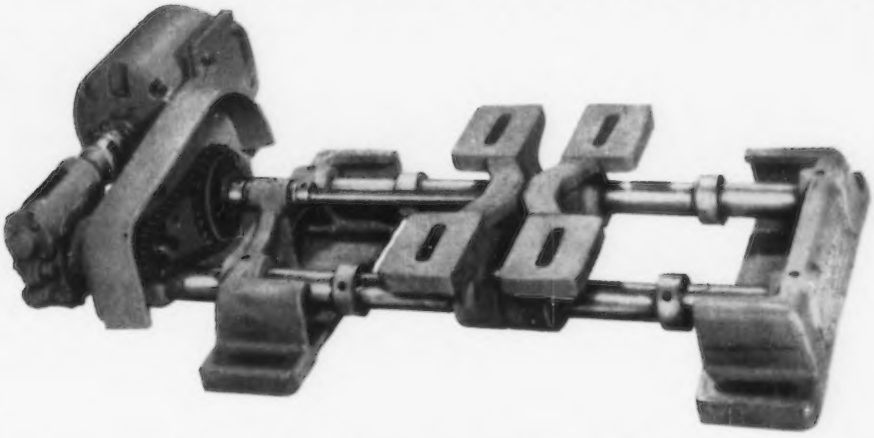
This unique feature is the result of "positive pulley adjustment." A positively-linked speed control system reciprocally adjusts the variable pitch pulleys. Unlike spring-equipped drives which constantly maintain maximum belt tension to meet occasional peak loads, belt tensions in a Worthington drive never exceed the actual load transmitted. Peak and momentary starting loads are transmitted just as smoothly as they would be with a standard fixed speed V-belt drive.

Positive pulley adjustment also results in a compact design with inherently long belt life. The wide-angle design of the belt offers deep side walls for greater contact area. This feature gives you high power capacity with minimum belt pressure. The large diameter belt assures smooth, efficient operation with little wear.

The new line is available in speed variations up to 10:1 and horsepower ratings from ½ to 25 hp. You can specify finger tip speed control or one of the many types of remote controls – both automatic and mechanical. For complete information, write for Bulletin 1610-B1. Address Section MV-78, Worthington Corporation, Oil City, Pa.

WORTHINGTON

NEW COMPONENTS AND MATERIALS



Remotely Adjustable Motor Base Controls Speed

This unit is designed for use where the pulley drive is inaccessible or where speed changes must be made or controlled remotely. Pushbutton control stations, which can be installed anywhere, provide fingertip control for infinite speed adjustment.

Suitable for use with fractional to 25 hp motors. Has been applied to machine tools, materials handling equipment.

Unit consists of fhp motor (available in single-phase, 110/220 v; three-phase, 220/330 v), shaft-mounted gear reducer, chain drive, and overload-protection clutch. Mounted on a bracket integral with adjustable motor base.

Models are available from stock in sizes from 3 to 13 in. OD: price ranges from $5 to $50. **Gerbing Mfg. Corp., 11800 Milwaukee Ave., Northbrook, Ill.**

Circle 1, inside back cover

Miniature Speed Reducers for Light Duty

One of these reducers is of miter-gear design, with 1:1 ratio and a horizontal, right-angle drive. It weighs only 3.75 lb. Rated output ranges from 0.33 to 0.333 hp.

The two other reducers are worm-gear assemblies. Model T109 is designed with the worm gear over, and Model U109 with the worm gear under. Ratios for both range from 5:1 to 30:1, and output from 0.03 to 0.08 hp. All are available from stock. **Boston Gear Works, Quincy 71, Mass.**

Circle 2, inside back cover

CONTINUED ON PAGE 94

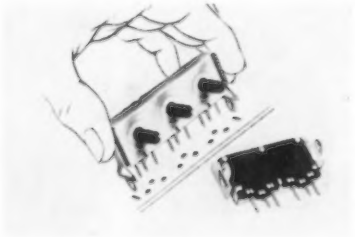
Reset counter . . .

with double driveshaft is supplied with three or four figures. It is enclosed in a nylon case to protect internals. Complete counter is $\frac{7}{8}$ x $1\frac{5}{32}$ x $1\frac{7}{16}$ in.; weight, 1 oz. Drive and reset shafts are stainless steel for corrosion resistance; actuating parts and figure wheels are nylon.

The counter is unaffected by temperatures of —30 to 280 F. It records revolutions or fractions at intervals of as little as 20 millisec (1000 strokes/min). Counter returns to zero after max capacity is reached.

Free end of double driveshaft can be used to transmit actuation to some other part of equipment to which the counter is connected. **Technicraft, 6222 Ridge Ave., Philadelphia 28.**

Circle 3, inside back cover



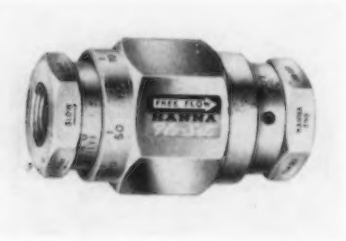
Plug-in side-by-side controls . . .

in 12 basic types, each with 17 shaft lengths, eliminate many of the production operations needed to mount separate conventional controls. The two and three-unit variable resistors have printed wiring terminals and snap-in metal mounting brackets to provide firm support for the multiple control assemblies. Screwdriver-slotted phenolic shafts are adjustable from both sides. Longer shaft extensions on one side are offered in standard lengths, —0.024 to 1.270 in. from mounting surface. Terminals are either parallel or perpendicular to shafts. Plug-in mounting brackets can be furnished for chassis or panel mounting. **Electronic Components Div., Stackpole Carbon Co., St. Marys, Penna.**

Circle 4, inside back cover

Speed control valve . . .

for service at 1000 psi controls speed of hydraulic cylinders and other hydraulically operated devices. Made in $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$-in. sizes. When used with cylinders,



these valves allow instroke and outstroke speeds to be regulated separately by permitting free flow through the valve in one direction and a controlled flow in the opposite direction. Flow can be controlled from zero to desired capacity with one revolution of the calibrated adjustment sleeve. When the desired flow rate is established, valve can be locked in position by a setscrew and locking collar. **Hanna Engineering Works, 1765 Elston Ave., Chicago 22.**

Circle 5, inside back cover

High-temperature cement . . .

seals most glasses, including lead, lime and barium-flint types, ceramics to glass, ceramics and metal to glass, and metal to metal. It is now being used to seal face panel to funnel of all-glass color TV tubes. Toothpaste-like material permits sealing between 752 to 842 F. Its service temperature is the same as its sealing temperature. A short heat treatment transforms the cement into a strong glass-ceramic. Materials to be sealed must be able to withstand high sealing temperature. **Corning Glass Works, Corning, N. Y.**

Circle 6, inside back cover

Fluorocarbon-rubber compound

resists many petroleum oils, synthetic lubricants, silicate esters and aircraft fuels in a temperature range from about 50 to over 500 F. Among the products being produced from this compound are O-rings, gaskets and seals with max resistance to deterioration by heat and fuels. **H. O. Canfield Co., Inc., Bridgeport, Conn.**

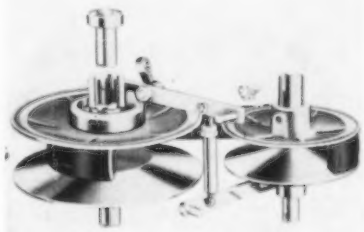
Circle 7, inside back cover

Small stroke counter . . .

with left-hand or right-hand drive and speed up to 1000 counts/min for equip-

ment requiring an inexpensive medium-duty stroke counter. Working parts are of stainless steel and nylon. Case and cover are die-cast zinc. The counter, designed with tongue-and-groove fit between cover and base, is entirely sealed. Dimensions are $2\frac{3}{4}$ x $1\frac{3}{8}$ x $1\frac{7}{16}$ in. deep; weight is $4\frac{1}{4}$ oz. **Durant Mfg. Co., 1938 N. Buffum St., Milwaukee 1.**

Circle 8, inside back cover



Mechanical variable-speed drives

provide infinitely variable speeds from 4600 to 1.2 rpm in speed variations of 2:1 to 10:1. Speed is varied by a special ribbed V-belt and dual variable-pitch pulleys mounted on parallel shafts. Pulley control can be adapted to manual, semi-automatic or automatic controls. Available in both integral and separate motor construction. The latter meets JIC specs. Can be mounted in any position. **Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles 22.**

Circle 9, inside back cover

Photoelectric cell . . .

needs no power supply; interrupting or restoring a light beam actuates relay that performs control functions. Several models are available. Operates on objects of all sizes and shapes without physical contact with the material. There is no mechanical linkage to the machine. The unit is self-contained. Operates within 15 ft with light source on 115 or 230 v, 50/60 cps. Visible contacts are DPDT, 5 amp, 115 v ac, noninductive. Ambient

CONTINUED ON PAGE 96

DESIGN FLEXIBILITY
plus PROVEN PERFORMANCE...

R&M UNIVERSAL MOTORS

foot mounting

end mounting

pad mounting

When you build-in R&M Motors... you build in customer satisfaction

R&M Universal Motors have proven to be dependable performers in hundreds of OEM products used by millions of satisfied customers. You can be sure your product will give more years of reliable, trouble-free operation if it's powered by R&M.

Design engineers prefer R&M Universal Motors for their broad design flexibility. Consider these variables on standard models: AC or DC operation . . . 1/50 to 1/2 hp . . . pad, foot or end mounted . . . rotation in either direction . . . open or totally enclosed. Custom designs with special ratings are also available.

Build customer satisfaction into your next product! Write today for R&M Bulletin 444-PE!

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO | BRANTFORD, ONTARIO

Robbins & Myers build motors from 1/200 to 200 horsepower

temperature range is 32 to 150 F. The photoelectric control can handle to 600 operations per min. **Machinery Electrification, Inc., 56 Hudson St., Northboro, Mass.**

Circle 10, inside back cover

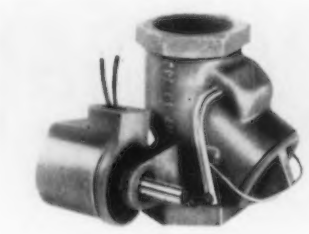
Midget high-pressure valve . . .

has a body slightly larger than an ordinary postage stamp. Designed for ¼-in. tubing to handle to 15,000 psi. The stem is nonrotating. Available in stainless steel, Monel or Hastalloy, adaptable for standard compression, socket weld and IPS connections. The capacity of the system, with a minimum of holdup is suitable for gage lines, instrument, sampling and catalytic injection systems. **High Pressure Equipment Co., Inc., Dept. PEN, Erie, Penna.**

Circle 11, inside back cover

Solenoid-operated drain valve . .

is designed for use wherever controlled draining or dumping of liquids is required. The direct-acting, solenoid-controlled valve has no cavities or obstructions to collect foreign matter. A clean-out plug, easily accessible, permits maintenance. Valve is all-iron, with stainless steel seat, including a watertight solenoid enclosure. Soft composition disk and stainless steel seat provide tight shutoff on 5-ft head



pressure. Dumping capacity is to 118 gpm. Available in 1¼ and 2-in. sizes. Operates on 15 w ac and may be supplied for most standard voltages and frequency. **Automatic Switch Co., Florham Park, N. J.**

Circle 12, inside back cover

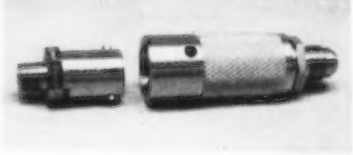
Metering valves . . .

made of Type 316 stainless steel are equipped with slow rising stems that require 20 complete turns to open or close the valve. All valves are furnished with a $\frac{1}{16}$ or ⅛-in. orifice and a ⅛ or ¼-NPT female connection. A locknut for panel mounting is standard. Max operating pressure is 3000 psi. O-ring is Teflon. **Hoke, Inc., 136 S. Dean St., Englewood, N. J.**

Circle 13, inside back cover

Quick-disconnect couplings. . .

with and without self-sealing members in each coupling half operate freely with either liquid oxygen or liquid nitrogen at —300 to —320 F and also with other materials that do not affect the Teflon or



Kel-F seals or stainless steel components of the couplings. Self-sealing member couplings can be coupled or uncoupled under pressure. There is no external leakage when connecting both halves of the coupling even if the system is under pressure, minimizing the hazards in handling low-temperature materials.

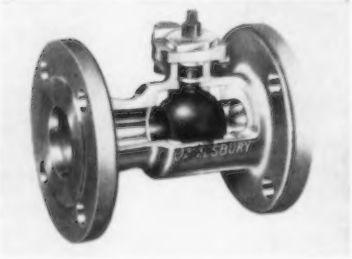
Coupling or uncoupling requirement under 25 oz-in. of pressure. A visual aid determines when the coupling is in locked detent position. **Essex Mfg. Co., Inc., 8213 Gravois Ave., St. Louis 23.**

Circle 14, inside back cover

Subminiature time-delay relays

were originally designed for aircraft, missile and rocket applications. Available in models for dc in settings from 1 sec to 1 hr and for 400 cps operation in time delay settings from 15 sec to 3 hr. Up to three switches can be supplied in the basic design. Basic weight of one switch is 7½ oz. Add ½ oz for extra switch; 1¾ oz for radio filter; ⅝ oz for governor; ⅛ oz for extra header. Hermetically sealed units vary in over-all length from $2\frac{33}{64}$ in. to $3\frac{7}{16}$ in. **A. W. Haydon Co., Waterbury, Conn.**

Circle 15, inside back cover



Small flanged valves . . .

in ¼ to 2 in. sizes has unit-body construction, positive shutoff, low torque over complete pressure range from vacuum to full-rated pressure, high flow capacity with min friction loss, and seats and seals that are interchangeable and replaceable. Available from stock. **Jamesbury Corp., Worcester, Mass.**

Circle 16, inside back cover

Rotary, oil-free pump . . .

is equipped with shaft seals for gas-tight operation at pressure to 10 psi. It has graphite vanes and bearings that require no lubrication. Shaft seals also require no lubrication and pump components cannot contaminate air or gas stream. Shaft seals make pump particularly adapt-

CONTINUED ON PAGE 98

J&L

RESTRICTED SPECIFICATION COLD ROLLED STRIP STEEL

for Spring Steel Requirements such as these . . .

FORMED PARTS FOR HEAT TREATMENT

SIZE	8 x .036
ANALYSIS	1050
FINISH	Bright
HARDNESS	Rockwell B-78 Max.
THICKNESS TOLERANCE	± .0003 incl. crown
WIDTH TOLERANCE	± .005
MICROSTRUCTURE	Uniform spheroids
COIL SIZE	16" I.D. coils large as possible
PACKAGING	On skids — shrouded

FLAT PARTS FOR HIGH STRENGTH WITHOUT HEAT TREATMENT

SIZE	10 x .020
ANALYSIS	1075
FINISH	Bright
HARDNESS	Rockwell C-30 Min.
THICKNESS TOLERANCE	± .001 incl. crown
WIDTH TOLERANCE	± .005
MICROSTRUCTURE	Small-fine carbides
COIL SIZE	16" — I.D. Max. coil wt. 1000#
PACKAGING	On skids — shrouded

Knowing exactly what you require for most efficient fabrication and most effective product performance, J&L can set up and consistently meet restricted specifications to match your most exacting demands. Often production operations can be greatly simplified or even eliminated; in most instances end-product and/or assembly costs can be reduced and quite frequently, product quality improved.

We would welcome an opportunity to explore with you the possibilities of J&L Restricted Specifications applied to your strip steel requirements.

THE 4 IN 1 SOURCE FOR YOUR

COLD ROLLED STRIP STEEL

Now there are four J&L plants with facilities for production of "Restricted Specification" cold rolled strip. Strategic locations at Youngstown, Indianapolis, Los Angeles and Kenilworth, N. J., provide the security of 4 sources of supply plus the close working relationship which these local production centers make possible.

SIZE	14 x .040
ANALYSIS	1095
FINISH	Bright
HARDNESS	95 to 105 Rockwell B suitable for blanking
THICKNESS TOLERANCE	± .0005 incl. crown
WIDTH TOLERANCE	± .005
MICROSTRUCTURE	Uniform medium size spheroids
COIL SIZE	16" — I.D. Max. coil wt. 600#
PACKAGING	On skids — shrouded.

J&L STEEL

Jones & Laughlin
STEEL CORPORATION
STRIP STEEL DIVISION
GENERAL OFFICES: YOUNGSTOWN 1, OHIO
PLANTS: YOUNGSTOWN • INDIANAPOLIS • LOS ANGELES • KENILWORTH, NEW JERSEY
SALES OFFICES: NEW YORK • ROCHESTER • NEWINGTON, CONN. • YOUNGSTOWN • CLEVELAND
DETROIT • INDIANAPOLIS • CHICAGO • LOS ANGELES • SAN FRANCISCO
FORMERLY THE COLD METAL PRODUCTS COMPANY

GET MORE ELECTRIC HEAT FOR YOUR MONEY!

with the WATLOW

FIREROD®

CARTRIDGE HEATING UNIT

5 to 10 times the life of conventional units

A new concept in design and manufacturing techniques has produced the FIREROD — capable of rendering 5 to 10 times the life of standard units, thus eliminating costly delays caused by burnouts. Because the FIREROD has the ability to operate at very high watts densities and temperatures, operation at normal watts densities and temperatures gives a greatly extended life and reduces your cost of operation.

More resistant to physical damage

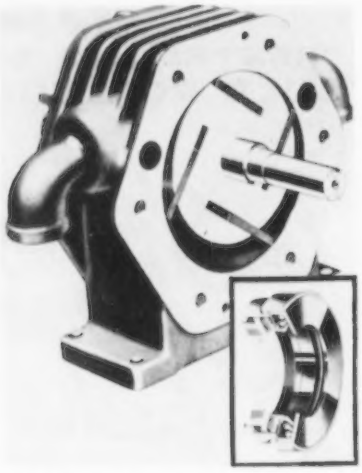
The rugged FIREROD is better able to withstand rough handling, shock and other field conditions (such as over-voltage surges) without the breakdowns encountered in ordinary units.

• *Watt for watt, the long lasting FIREROD offers you maximum value for your heating dollar.*

WRITE FOR **FIREROD** BULLETIN 365

WATLOW

ELECTRIC MANUFACTURING CO.
1392 Ferguson, Avenue
Saint Louis 14, Missouri



able for handling gases that might be harmful should they leak into surrounding areas. Cast iron construction is standard. Cylinder wall, end plates and shaft are precision ground. The balanced rotor, in which the vanes are seated, is suspended on double-sealed, grease-packed bearings. **The Dexter Co., Pearl River, N. Y.**

Circle 17, inside back cover

Small, low weight relays . . . has snap-over-action switch which eliminates floating contact, and double spiral spring. Design for nonresonance over a frequency range of 0 to more than 3500 cps. It provides good armature activity plus good armature stability from movement in undesirable planes. **Phillips Control Corp., Joliet, Ill.**

Circle 18, inside back cover

Polyester film material . . . remains flexible and stable over a temperature range of —85 to 350 F. Available as a flame-resistant film, aluminum-coated, or in special forms. Flame-resistant material is coated on one side, has an off-white color and is somewhat translucent. Nominal thickness of 50-gage film is 0.005 in. In 36 to 54-in. widths; 150-gage film is 0.0015 in. thick; 54 in. wide. Aluminum-coated film has high reflectivity because of a coating of vacuum-deposited aluminum on one side. Nominal thickness of 100 gage film is 0.0010 in. Available from stock in 36-in. widths. Other

(Continued on page 100)

PRECISION DYNA-SEAL

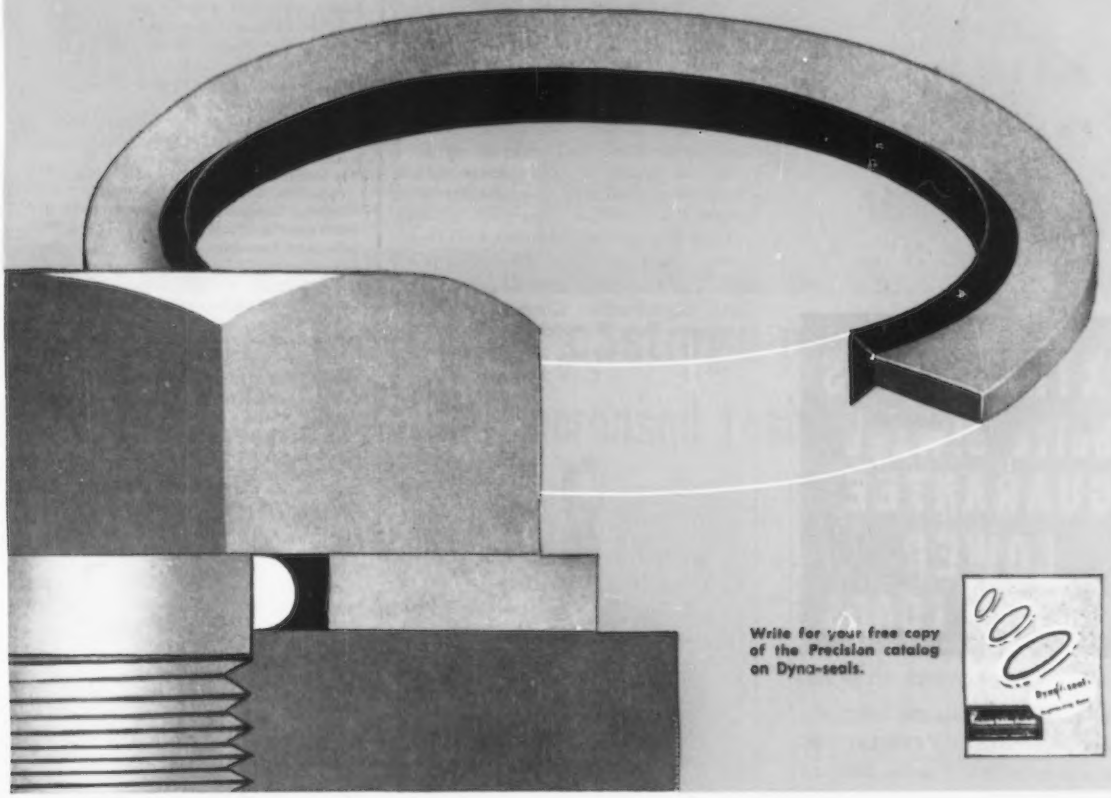
For face to face sealing

Easy-to-handle one piece seal of rubber bonded to a steel washer.

Available in-stock sizes for No. 5 screw to 1-¼" bolt.

No special machining required.
Reduces assembly costs.
Positive sealing up to 10,000 P. S. I.
Vibration proof, lock washer action.
Reduces bolting torque.
Reusable - cuts maintenance.

Let a Precision engineer demonstrate the Dyna-seal cost and labor saving advantages to you.



Write for your free copy of the Precision catalog on Dyna-seals.

Precision Rubber Products Corporation

"O" Ring and Dyna-seal Specialists

Dept. 3, Oakridge Drive, Dayton 7, Ohio **Canadian plant at: Ste. Thèrése de Blainville, Québec**

EXTREMULTUS belts always GUARANTEE LOWER BEARING LOADS

Belt speed capabilities over 10,000 feet per minute, narrower widths than any other belting, plus unequaled friction coefficient of EXTREMULTUS belts allow us to GUARANTEE bearing loads at a fraction of former values. The thin, elastic, incredibly strong polymer core of EXTREMULTUS soaks up shock without ever stretching, eliminates overtightening and delivers power without down time year after year. Write today for full information and descriptive catalog.

EXTREMULTUS, INC.
405 LEXINGTON AVE., NEW YORK, N.Y.

forms, such as flame-resistant film backed with cheesecloth or very lightweight fiberglass fabric may be ordered. Nonstock items require 6 to 8 wk lead time. **H. I. Thompson Fiber Glass Co., 1733 Cordova St., Los Angeles 7.**

Circle 19, inside back cover

Heavy-duty electronic relay . . .

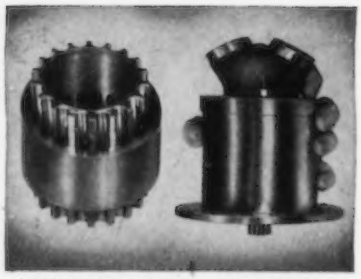
can receive a variety of input signals at low power levels and controls up to 5 amp on signals of milliw range. Automatic or manual reset is controlled by an internal slide switch. The resistance-operated device has a steel housing with knockouts. Input power is 115 v, 50 or 60 cps, 15 w. Output switching is rated 5 amp, noninductive. Contacts are SPDT. **Datascan, Inc., 48 Notch Rd., Little Falls, N. J.**

Circle 20, inside back cover

Nonmagnetic objects . . .

cause a phase shift in this proximity detection device, designed for counting applications. A metallic housing is used,

(Continued on page 104)



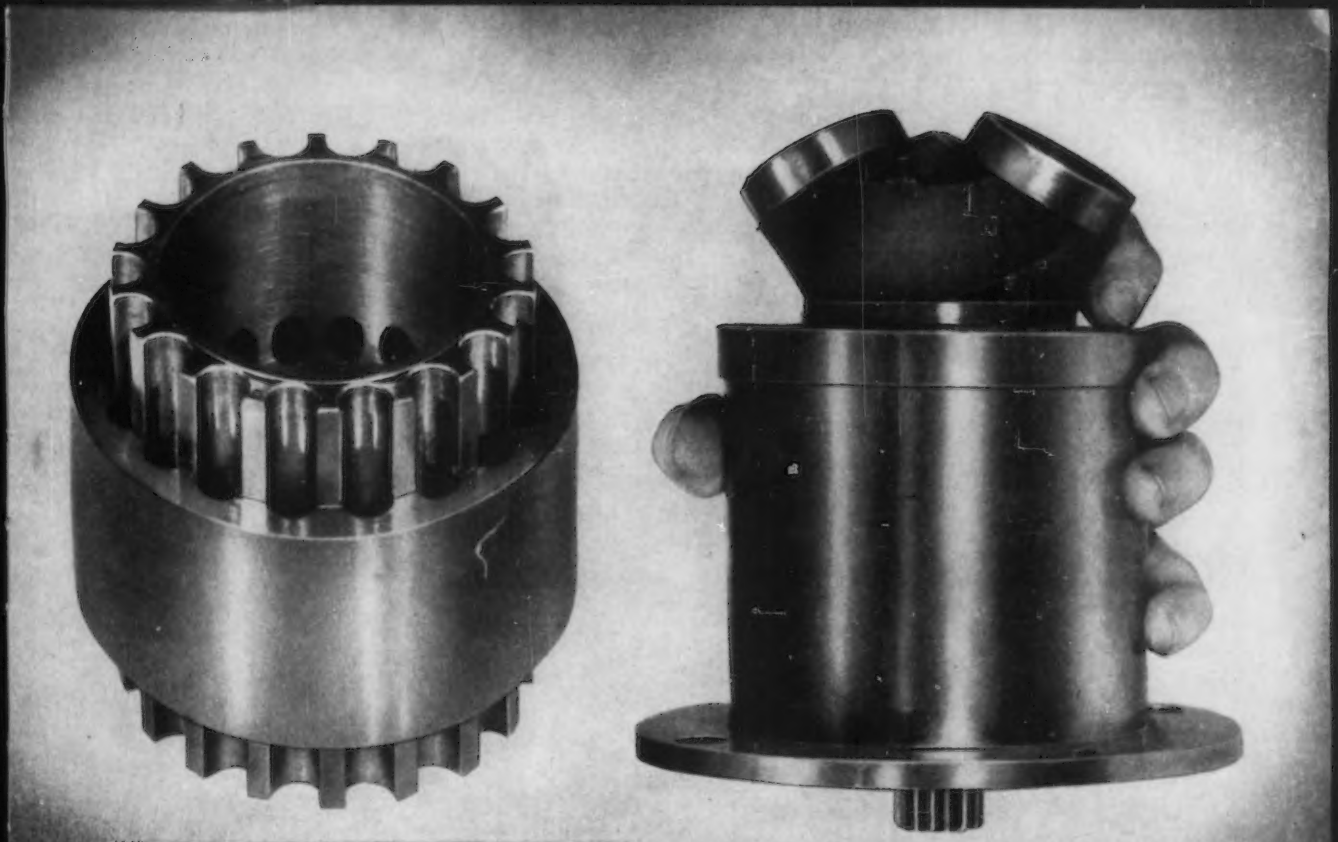
MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES

The American Laundry Machinery Co., Rochester, N. Y.
Atlas Foundry Co., Detroit, Mich.
Banner Iron Works, St. Louis, Mo.
Barnett Foundry & Machine Co., Irvington, N. J.
Blackmer Pump Co., Grand Rapids, Mich.
E. W. Bliss Co., Canton and Toledo, Ohio
Centrifugally Cast Products Div., The Shenango Furnace Co., Dover, Ohio
Compton Foundry, Compton, Calif.
Continental Gin Co., Birmingham, Ala.
The Cooper-Bessemer Corp., Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co., Portland, Ore.
Empire Patterns & Foundry Co., Tulsa, Okla. and Bonham, Texas
Florence Pipe Foundry & Machine Co., Florence, N. J.
Fulton Foundry & Machines Co., Inc., Cleveland, Ohio
General Foundry & Mfg. Co., Flint, Mich.
Georgia Iron Works, Augusta, Ga.
Greenlee Foundries, Inc., Chicago, Ill.
The Hamilton Foundry & Machine Co., Hamilton, Ohio
Hardinge Company, Inc., New York, N. Y.
Hardinge Manufacturing Co., York, Pa.
Johnstone Foundries, Inc., Grove City, Pa.
Kanawha Manufacturing Co., Charleston, W. Va.
Koehring Co., Milwaukee, Wis.
Lincoln Foundry Corp., Los Angeles, Calif.
Nordberg Manufacturing Co., Milwaukee, Wis. and St. Louis, Mo.
Palmyra Foundry Co., Inc., Palmyra, N. J.
The Henry Perkins Co., Bridgewater, Mass.
Pohlman Foundry Co., Inc., Buffalo, N. Y.
The Prescott Co., Menominee, Michigan
Rosedale Foundry & Machine Co., Pittsburgh, Pa.
Ross-Meehan Foundries, Chattanooga, Tenn.
Sonith Industries, Inc., Indianapolis, Ind.
Standard Foundry Co., Worcester, Mass.
The Stearns-Roger Mfg. Co., Denver, Colo.
Valley Iron Works, Inc., St. Paul, Minn.
Vulcan Foundry Co., Oakland, Calif.
Washington Iron Works, Seattle, Wash.
Dorr-Oliver-Long, Ltd., Orillia, Ontario
Hartley Foundry Div., London Concrete Machinery Co., Ltd., Brantford, Ontario
Otis Elevator Co., Ltd., Hamilton, Ontario

"Heat Treatment of Meehanite®"

Write for your free single copy today
Technical Data Sheet No. 5.
Write today to Meehanite Metal Corporation, Dept. 7G, 714 North Avenue, New Rochelle, N. Y.

MEEHANITE®



Heat treated Meehanite castings provide the answer for this variable speed displacement pump which must operate under pressures of 2,000 to 5,000 lbs. psi. Meehanite metal resists wear and remains dimensionally stable.

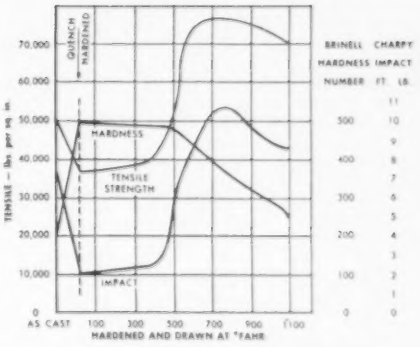
Heat treated Meehanite castings provide higher strength, toughness and increased resistance to wear

Because of its uniform structure, heat treated Meehanite® may be machined at higher Brinell hardness values and assures strong, tough, hard wearing castings able to withstand severe service conditions.

The main objectives in the heat treatment of Meehanite® are: to stress relieve complex castings by removing internal strains without changing physical properties; to improve machinability without loss of strength and hardness; and to obtain greater hardness, strength, toughness and wear resistance.

Heat treated Meehanite castings are finding wide applications in engineering components because of their superior strength characteristics, high damping capacity, pressure tightness, dimensional stability and uniformity.

If you would like more information about the heat treatment of Meehanite castings, consult a Meehanite foundry and write today for your copy of Technical Data Sheet No. 5.



The effect of quench and draw treatment on the impact strength and hardness of type GA Meehanite is portrayed above.

MEEHANITE BRIDGES THE GAP BETWEEN CAST IRON AND STEEL®

MEEHANITE METAL

MEEHANITE METAL CORPORATION, NEW ROCHELLE, NEW YORK

SYNCHRON®
TIMING MOTORS

Precision Engineered for Dependable Power

UL and CSA approvals

SYNCHRON synchronous motors operate smoothly, evenly in any position at temperatures from −40° to +140° F., start instantly under load; pull up to 20 in. oz. at 1 RPM. Available in 42 speeds from 0.8 RPM to 600 RPM.

1 **PATENTED TWO-PIECE FIELD STRUCTURE** having wide and narrow poles, with rotor that rotates between inner and outer field poles. The inner and outer poles are properly shaded with heavy, continuous copper rings to assure maximum starting and running torque.

2 **DOUBLE BEARINGS** in reduction train on rotor shaft assure smooth operation.

3 **ALUMINUM ROTOR RING SUPPORT.**

4 **PATENTED, HARDENED STEEL ROTOR RING.**

5 **OIL STORAGE RESERVOIR** with patented oil feed to bearings.

6 **HEAVY BRASS ROTOR COVER.**

7 **DOUBLE BEARINGS ON OUTPUT SHAFT.**

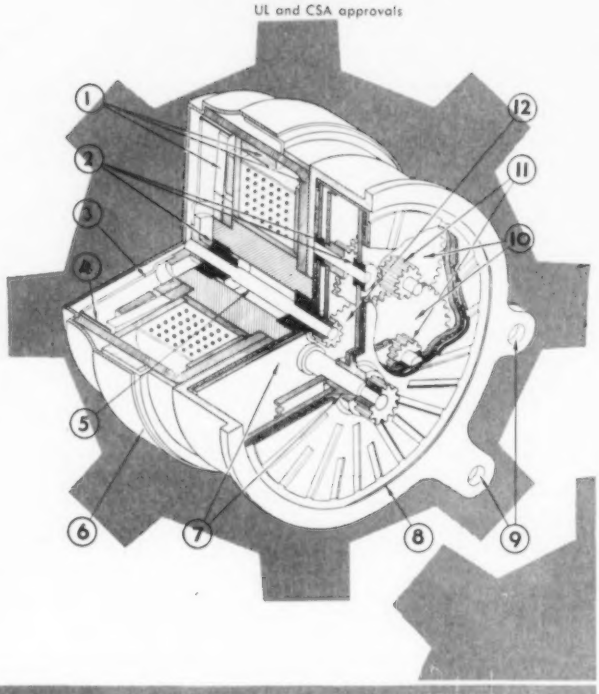
8 **GEAR CASE SEALED** against oil leakage to permit mounting in any position.

9 **FOUR CONVENIENT MOUNTING HOLES.**

10 **BRASS GEARS.**

11 **STEEL PINIONS.** Note: Brass against steel assures longer life.

12 **BAKELITE GEAR** for quiet operation.



STANDARD TIMING MOTOR (8 IN. OZ.)
Compactly built to space saving dimensions, with rotor and coil packed in a sturdy hand - sized case. Used in timing devices and controls of all types. Guaranteed torque 8 in. oz. at 1 r.p.m.

HI-TORQUE TIMING MOTOR (20 IN. OZ.)
There's big power packed into this versatile timing motor. One year guarantee. Dependable, accurate, trouble-free. Guaranteed torque 20 in. oz. at 1 r.p.m.

SLO-MOTION SYNCHRON (1 R.P.H.)
A new timing motor developed especially for slow motion jobs. Guaranteed 20 in. oz. at 1 r.p.h. (1/60 r.p.m.)

HANSEN CLOCK MOVEMENTS
For standard and office clocks, sign clocks, novelty clocks, and clocks of all kinds up to 26" in diameter under glass. Precision power with a Synchron timing motor.

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Designed for aircraft instruments and radio controls. Armed Forces applications have proved its top performance worldwide under all operating conditions. Easily adapted to commercial uses.

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"Workhorse of the industry"
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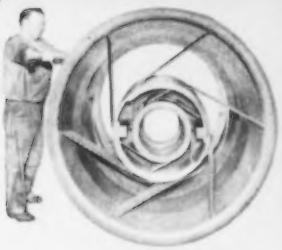
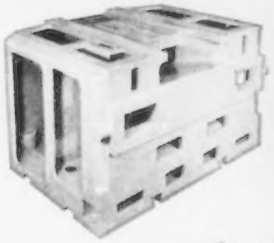
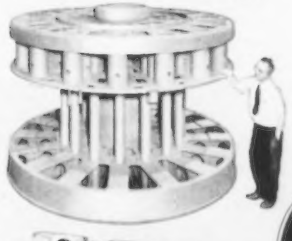
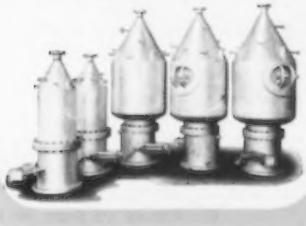
Steel-Weld FABRICATION









Use WELDED STEEL for Greater Strength with Less Weight!

The weldment shown above is the frame for a sixteen cylinder Diesel Engine designed for a potential of 5000 H.P. This precision piece, and those illustrated at the left are typical of thousands of Steel-Weld Fabricated parts and assemblies produced by Mahon each year for manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment. If you are not now taking full advantage of the economies offered by welded steel components in your product, you should give the matter serious thought. In the design of almost any type of heavy machinery there are parts and sub-assemblies that can be produced more economically, more satisfactorily, and in less time, in welded steel. In weldments you get greater strength with less weight—plus the additional advantages of greater rigidity and 100% predictability. When you consider weldments, you will want to discuss your requirements with Mahon engineers, because, in the Mahon organization you will find a unique source for weldments or welded steel in any form . . . a fully responsible source with complete facilities for design engineering, fabricating, machining and assembling . . . a source where design skill is backed up by craftsmanship which assures you a finer appearing product embodying every advantage of Steel-Weld Fabrication. See Sweet's Product Design File for information, or have a Mahon sales engineer call at your convenience.

THE R. C. MAHON COMPANY • Detroit 34, Michigan

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Engineers and Fabricators of Steel in Any Form for Any Purpose

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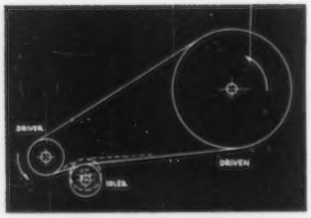
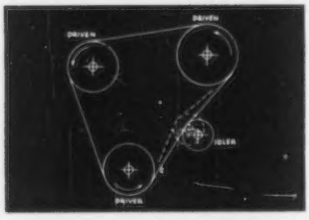

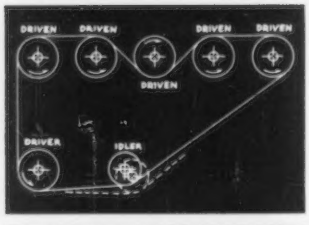
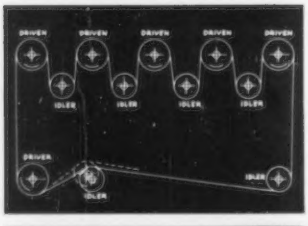
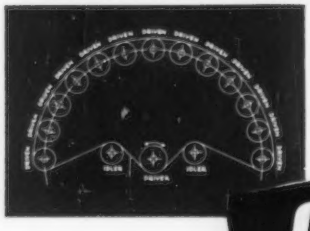

for efficiency and economy

drive it with ACME chains and sprockets

In any drive where maximum efficiency is essential you will find Acme precision roller chain and sprockets are readily adaptable. Illustrated at the left are several drive applications.

Use Acme Chain drives wherever dependable, efficient and economical transmission of power between parallel shafts is required. Their correct principle of design provide operating characteristics superior to any other means of power transmission. Acme Chains and Sprockets deliver Positive – Efficient – Economical – Flexible – Rugged – and Quiet Power Transmission. Send your power transmission problems to Acme for the right solution.

Write Dept. 1-S for new 100-page Illustrated Catalog, including new engineering section showing diagrams of 36 methods of chain driving.

Acme Chain Corporation
HOLYOKE MASSACHUSETTS

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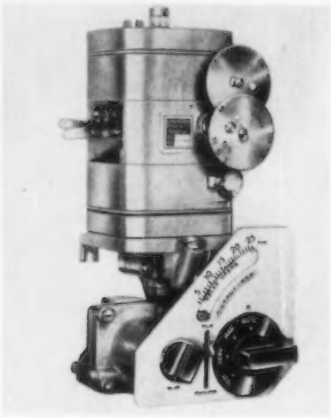
COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS

consisting of nylon liner, bakelite bobbin and bakelite shell. Nonmagnetic parts passing through the coil actuate the control relay. The coil consists of two aiding primaries and two bucking secondaries. Sensitivity is controlled by the adjustment of a screw, distorting the field of one primary and one secondary winding to unbalance the system. **Automatic Timing & Controls, Inc., King of Prussia, Penn.**

Circle 21, inside back cover



Pneumatic controller . . .

has a regenerative feedback circuit. Handles both pneumatic and mechanical signals, simply by changing one subassembly. The same basic design is used with miniature or conventional instruments and provides a complete selection of controller modes. **Fischer and Porter Co., 521 Jacksonville Road, Hatboro, Penna.**

Circle 22, inside back cover

High-strength hinge . . .

applies pressure along the hinge-line of hinged-cover containers. Springless, impact-resistant design insures a pressure-tight seal where gasketing is used. It is not affected by sub-freezing temperatures. Positive locking is accomplished manually by a half-turn on the wing nut. When

(Continued on page 106)

"PONY POWER" MOTORS

that give stamina to your products

Lamb Electric ***fractional*** horsepower motors, like the small horses of the famed western-pioneer-day Pony Express, are developed for *stamina.*

Their dependability, and efficiency (optimum weight-size-horsepower ratio) are qualities that result from proper design and careful manufacture by personnel with many years of experience in the small motor field.

May we demonstrate how Lamb Electric Motors can bring these advantages—and also perhaps lower costs—to *your* products?

THE LAMB ELECTRIC COMPANY • KENT, OHIO

A Division of American Machine and Metals, Inc.

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Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

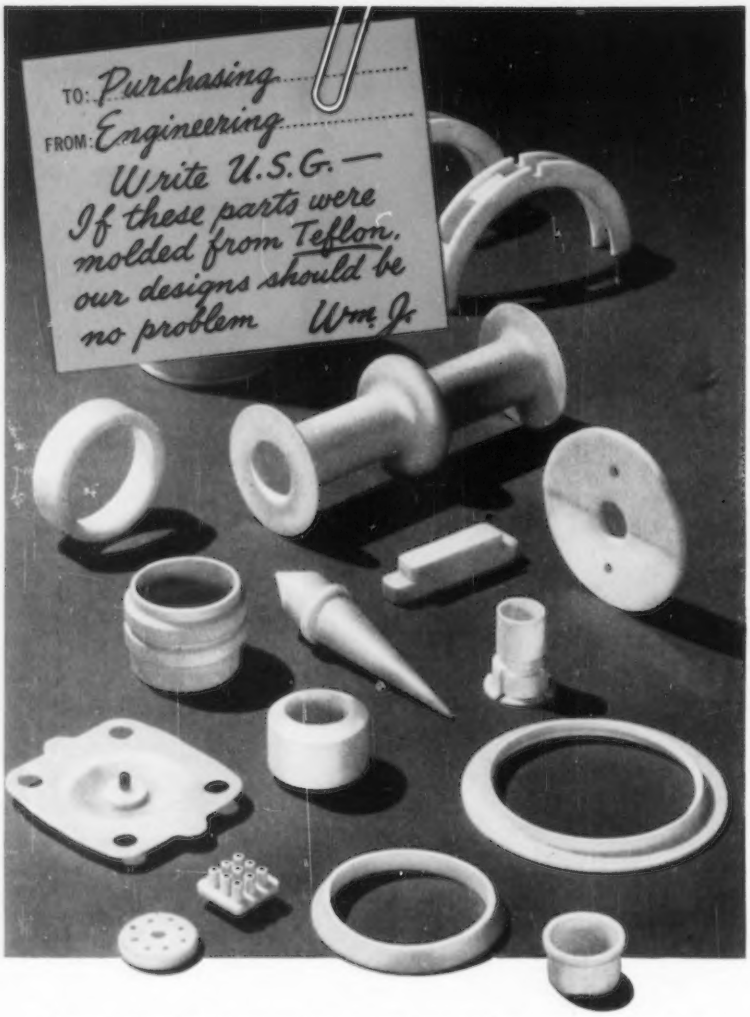
A rugged high-torque, high-speed motor.

Radar voltage regulator gear motor.

Motor with efficient spur gear speed reducer.

Motor for high-speed grinder.

If you are interested in any of the above motors write and we shall be glad to send full information.



Never underestimate the molding possibilities of TEFLON*, in the hands of United States Gasket.

True, it is probably the most difficult of all plastics to mold. But U.S.G. specializes in difficult moldings, involving precision tolerances, intricate shapes, inserts, molding around metallic structures, etc.

They are equipped with unusual "know-how" gained as pioneers and leaders in fluorocarbon plastics fabrication, and the most modern specialized facilities and techniques for cold molding and sintering of TEFLON T.F.E., as well as the injection molding of KEL-F† and the new thermoplastic TEFLON F.E.P.

Send us your difficult fluorocarbon molding problems for quotations. And call upon us, too, for your requirements of fluorocarbon and nylon sheets, discs, tape, rods, tubing, bars, cylinders, etc., from the world's largest and most complete stocks.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses throughout the U.S. and Canada, or write

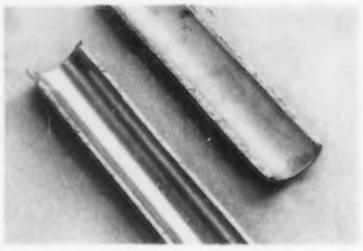
†M.M.&M. Trademark
**du Pont Trademark*

United States Gasket Company
Camden 1, New Jersey

United States Gasket *Plastics Division of* **GARLOCK**

pressure is released by a counter turn, the hinge becomes free-operating. Available in medium and light-duty versions with matched fasteners of same size. Medium-duty hinges have a load-carrying capacity to 1000 lb tension; over-all length, secured, is 4⅜ in; width, 1⅛ in. Light-duty hinges have a load-carrying capacity to 300 lb in tension; over-all length, secured, 2 7/16 in. x ⅞ in. wide. **Simmons Fastener Corp., North Broadway, Albany 1.**

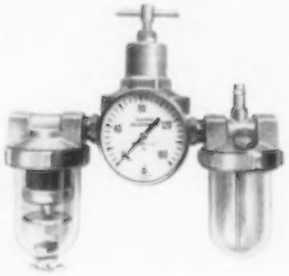
Circle 23, inside back cover



Seamless stainless tubing . . .

is made in sizes with ⅜ to 1½ in. OD and 0.020 to 0.109 in. wall thickness. Mandrel-drawn stainless tubing is produced by several operations: cold reduction on reducing machines, controlled-atmosphere bright annealing and lubricated drawing procedures. Interior has mirror-like surface that resists clinging by solid particles. **Summerill Stainless Tube Div., Columbia Steel and Shafting Co., Carnegie, Penna.**

Circle 24, inside back cover



High-capacity regulator . . .

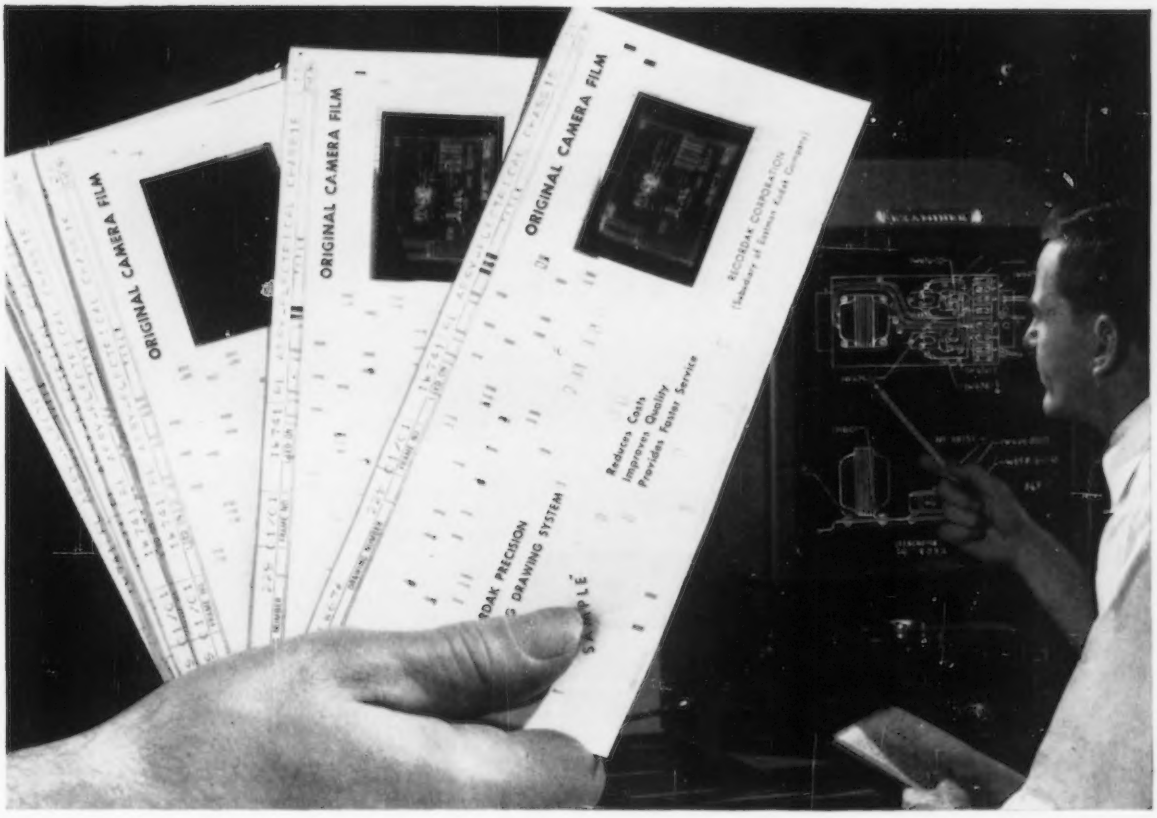
for pressure regulation of air, water, oil and gases in filtering or lubricating systems. With inlet pressure of 200 psi and a reduced pressure of 80 psi at no-flow, the flow can be increased to 80 cfm of free air with a pressure drop of 2 psi. **Generant Engineering Co., 260 S. 20th St., Newark 3, N. J.**

Circle 25, inside back cover

Sealed toggle switches . . .

with integral terminal construction and new step-design case offer ease in wiring. Switches are available with all types of

(Continued on page 108)



Decks of cards replace acres of files

New Recordak Engineering drawing system simplifies filing, reference, printmaking and print distribution . . . seems destined to change drafting-room procedures the world over.

An exclusive Recordak development. New microfilming techniques and quality-control methods perfected by Recordak give results never before achieved in 35mm microfilming. These pictures are of such outstanding quality they increase the scope of Filmsort aperture cards . . . supplant use of bulky blueprints and drawings in many drafting-room routines.

Just how do these new Recordak pictures differ from others?

In one important way—now, all types of drawings, prints, specification sheets—negatives or positives, old or new, clean or dirty—can be reproduced uniformly on low-cost 35mm Recordak microfilm *without loss of detail!* Important, too—enlargements made from them are as readable as the originals.

The next step in the Recordak System—mounting these superb Recordak reproductions on individual cards puts complete drawing files at fingertips . . . saves engineering time, steps up efficiency. Large organizations can realize further economies by correlating their use with existing mechanized filing, duplicating and enlarging systems.

See how new Recordak System helps: Files cut 95% • Any picture can be checked immediately in Film Reader • Microfilm cards can always be filed in any numbered sequence • Paper prints or duplicates made rapidly by photographic or electrostatic method • Branches, subcontractors supplied at lowest cost.

FREE BOOKLET tells how this System can work for you. Includes sample Recordak Microfilm frame mounted on Filmsort aperture card. Mail coupon today.

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originator of modern microfilming—*now in its 30th year*

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Address_____

City_____ State_____

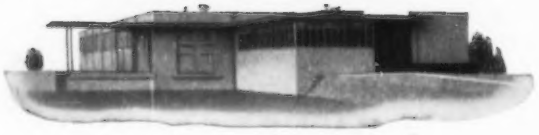
WHEN YOU NEED

TUBULAR RIVETS

IN A HURRY...

5 MILFORD PLANTS

...are within overnight trucking distance of your assembly line



Rivets can create "king-size" headaches when they aren't at your assembly line in the quantity you need—when you need them.

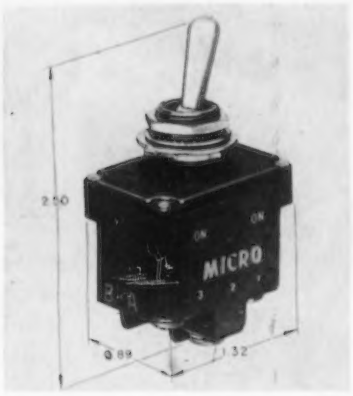
To give you unmatched delivery service on tubular rivets, Milford has five *manufacturing* plants and twenty sales offices strategically located across the country's industrial beltline.

To cut delivery time and production costs, to improve product appearance, to assemble your product on automatic rivet-setting machines—get in touch with Milford!

TUBULAR RIVETS
RIVET-SETTING MACHINES
COLD-FORMED PARTS

THE MILFORD RIVET & MACHINE CO.

MILFORD, CONNECTICUT • HATBORO, PENNSYLVANIA
ELYRIA, OHIO • AURORA, ILLINOIS • NORWALK, CALIF.



standard contact arrangements. Use of silicone seal between bushing and toggle lever, and nonhardening silicone sealant between cover and case prevent dust or moisture from entering. Chromium-plated brass toggle lever has antirotation control. Plastic case resists carbon tracking from an electrical arc. Switches include single, two and four-pole models. Rated electrically at 20 amp, 30 v dc, resistive load. **Micro Switch, div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.**

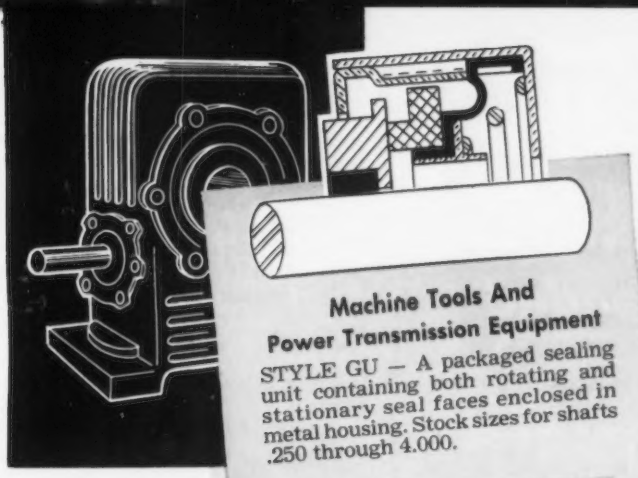
Circle 26, inside back cover

Brake for fhp motors . . .
is designed for use on stub, extended or through-shaft applications. This model retains basic, single-solenoid, lever action and unitized construction. Cast iron housing and endplate, visual wear indication, and automatic manual release and reset are standard. Available for operation on all standard ac voltages. For use with fhp electric motors in frames 56-C and 66-C, also integral motor frames 182 and 184. **Stearns Electric Corp., 120 N. Broadway, Milwaukee 2.**

Circle 27, inside back cover

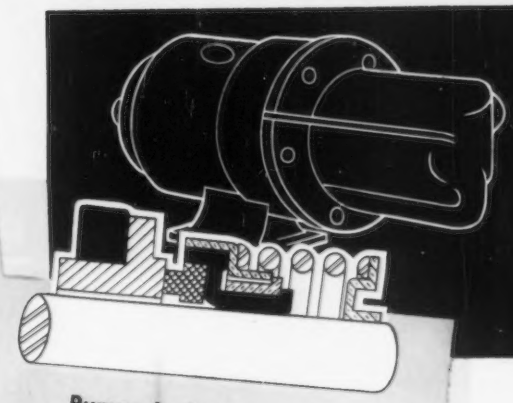
Abrasion-resistant alloy . . .
is a chromium cast iron with extremely hard, complex carbides embedded in a matrix of unstable austenite. After being cast in sand molds, the material is subjected to drastic open grid air quenching. When used for severe wear parts, it is re-

(Continued on page 110)



Machine Tools And Power Transmission Equipment

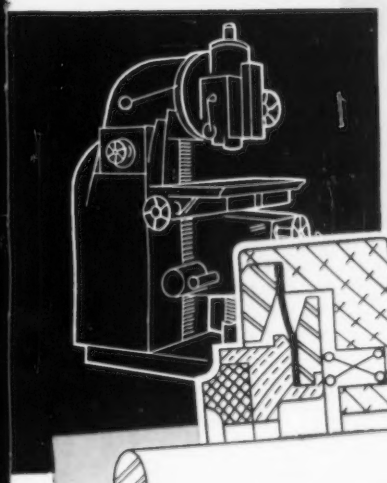
STYLE GU — A packaged sealing unit containing both rotating and stationary seal faces enclosed in metal housing. Stock sizes for shafts .250 through 4.000.



Pumps And Compressors

ROTO-FLEX — Rugged flexibility. Only 3 parts. Single or double units. Stock sizes for shafts .250 through 4.000.

STYLE RFO — A specially designed Roto-flex seal, for installation outside the stuffing box. Stock sizes for shafts .250 through 4.000.



Heavy Machine Tools

STYLE DPC — A high-speed, carbon-faced seal, for more compact installation in heavy industrial machinery. Stock sizes for shafts .250 through 4.000.

A Complete Line

GITS SHAFT SEALS

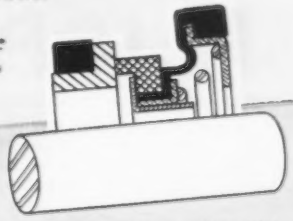
For Every Application

These modern, mechanical, face-type seals are carried in stock — to save you time and money. Write for detailed data.

GITS BROS. MFG. CO.

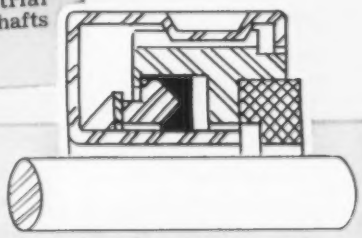
1838A South Kilbourn Avenue • Chicago 23, Illinois

Specialists In Lubricating Devices And Shaft Seals For Almost Half-A-Century



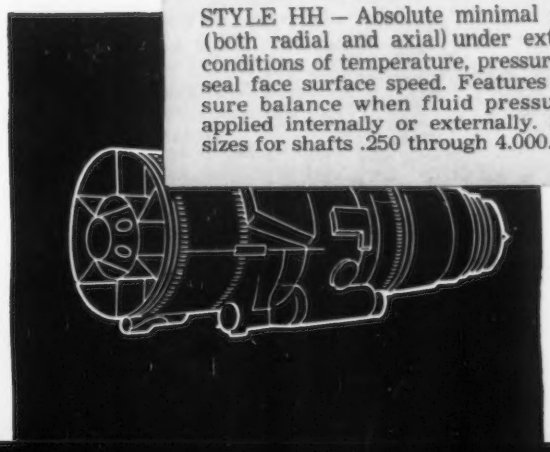
Household Appliances

STYLE SGU—A factory-assembled unit-type seal for the small-budget user. Stock sizes for shafts .250 through 1.000.



Aircraft Engines And Accessories

STYLE HH — Absolute minimal space (both radial and axial) under extreme conditions of temperature, pressure and seal face surface speed. Features pressure balance when fluid pressure is applied internally or externally. Stock sizes for shafts .250 through 4.000.



For Earthmoving Machines . . .

BIG GEARS needed

FAIRFIELD

can supply them!

GEARS to match the ever-increasing size and power of modern machines are a Fairfield specialty. This is possible because Fairfield has long been a leader in utilizing the most advanced methods, machines, and techniques for producing better gears. By keeping apace with modern engineering trends, Fairfield renders an invaluable service to many of America's machinery builders, both large and small.

At Fairfield, you get the benefits of high production rates and big volume output in an ultra-modern plant designed exclusively for producing fine gears EFFICIENTLY, ECONOMICALLY. Check with Fairfield NOW on your gear requirements. *Call or write.* FAIRFIELD MANUFACTURING CO., 2305 S. Concord Rd., Lafayette, Indiana. Telephone 2-7353.

A "PLUS VALUE" IN ANY PRODUCT

Gears and Differentials for FINE GEARS *Made to Order for:*

TRACTORS • HEAVY DUTY TRUCKS • AGRICULTURAL MACHINERY • POWER SHOVELS AND CRANES
MINING MACHINES • ROAD GRADERS • BUSES • STREET SWEEPERS • INDUSTRIAL LIFT TRUCKS

ported to have outworn competitive materials as much as 13:1. Cold working increases the hardness. Service life is exceptional where high abrasion resistance without excessive impact is desired as in sand impellers, pugmill blades and conveyor rolls. **Calumet Steel Castings Corp., 1636 Summer St., Hammond, Ind.**

Circle 28, inside back cover

Miniature alternator . . .

is 0.990 in. OD, 1⅜ in. long, weighs 4 oz. Available in one, two or three-phase output with various frequency ranges. Six-pole models develop 350 cps, 14 v and 80 milliamp at 7000 rpm with less than 5% distortion. A two-pole version develops less than 3% distortion. Output voltages and frequencies that can be modified to specific requirements. Unit meets military specs. **Eastern Air Devices, Inc., 385 Central Ave., Dover, N. H.**

Circle 29, inside back cover

Slip-clutch coupling . . .

requires no lubrication and is easily adjusted to transmit from zero to 4 in-lb torque. Units are stocked for immediate delivery in two mounting types. Dimensions are ¾ x 2 in. long. Clutches are $8.25 and $9.75 in quantities over 10. **Precision Specialties, Inc., 1342 E. 58th St., Kansas City, Mo.**

Circle 30, inside back cover

Metal honeycomb . . .

is made by crimping steel, titanium or other alloy ribbon to form one side of the honeycomb cell and welding it to

(Continued on page 112)

BLOOD BROTHERS SERVES INDUSTRY

WITH UNIVERSAL JOINTS AND ASSEMBLIES FOR ALMOST ANY PRODUCT APPLICATION

SIZES AND TYPES FOR HEAVY-DUTY AUTOMOTIVE, CONSTRUCTION AND ROAD BUILDING MACHINES, FARM IMPLEMENTS, TRACTORS AND INDUSTRIAL MACHINERY.

SAVE ENGINEERING TIME!

Here at Blood Brothers you can select from a wide, wide range of universal joints and complete drive assemblies. Torque capacities range from 350 to 500,000 inch lbs. — lengths from very close-coupled industrial joints to assemblies 120" overall.

You can be confident they are produced in a modern, centrally located plant, tooled for precision manufacturing. And you can rely on their high reputation for dependability.

When you specify Blood Brothers, you can save valuable engineering time by stating your problem to our service-minded engineers. They're cooperative, friendly and long-experienced. Just write or call.

WRITE FOR BULLETIN 557

and for your convenience in specifying, request our free Blank Form "Specification Sheets".

BLOOD BROTHERS MACHINE DIVISION

ROCKWELL SPRING AND AXLE COMPANY

ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

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STAINLESS STEEL "KNOW-HOW"
MAKES HUBBELL
MACHINE SCREWS
first choice for quality products
IT PAYS TO HAVE
HUBBELL
GOOD CONNECTIONS
PFLUEGER
THE GREATEST NAME IN TACKLE
"We want the very best screws possible . . . even though you may have to perform an unusual operation to do it."

The above statement is taken from the machine screw specifications of the Enterprise Mfg. Co., Akron, Ohio. It expresses their dedication to top quality, and it shows why so many other quality manufacturers, like Pflueger, are turning to Hubbell for their screw requirements.

This is particularly true in regard to austenitic chromium-nickel stainless steel machine screws, which require unusual manufacturing know-how. The ability, for example, to eliminate cracking which sometimes results from fabricating stresses; the ability to insure high tensile strength with maximum corrosion resistance; the ability to maintain pleasing appearance: all of these things are the result of long experience with stainless steel. In fact, Hubbell is the oldest company in the country making stainless steel machine screws.

This specialized knowledge is yours for the asking. For price and delivery information send blueprint or sample of the item.

HARVEY HUBBELL, INC.

HIGHEST QUALITY
WIRING DEVICES • MACHINE SCREWS

OVER 60 YEARS' EXPERIENCE in the manufacture of highest quality, rolled thread machine screws and special cold headed parts.

MACHINE SCREW DEPARTMENT BRIDGEPORT 2, CONNECTICUT

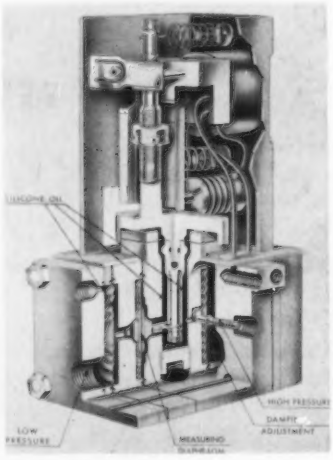
another piece of crimped material to form a complete cell. This is continued until the required length has been built up as a prestretched, stress-relieved honeycomb. This eliminates tearing or separation of cells when stretching. Close thickness tolerances, ±0.003 in., are held so that no final machining is needed. Cell sizes are $\frac{1}{8}$, $\frac{3}{16}$, and $\frac{1}{4}$ in. Foil gages are 0.001, 0.0015, 0.002, 0.003, 0.004, 0.005 in. Core depth up to 1 in. is available. Cells are square and perforations are available where pressure equalization is required. **H. I. Thompson Fiber Glass Co., 1733 Cordova St., Los Angeles 7.**

Circle 31, inside back cover

100% reactive film adhesive . . .

and bonds flat metal sheets together, flexible plastic films to rigid and semirigid metals, and plastics, metal and plastic skins to honeycomb cores. A high-strength, porous paper is carrier for the latent adhesive. The 4-mil adhesive film is applicable to sandwich applications where void-filling and filleting are desired. Four alternate methods of reactivating the adhesive range from simple solvent-reactivation to heat-reactivation and curing under pressure. Strength in excess of 1000 psi. accompanied by excellent peel strength are provided by pressure curing method. Available from stock in 36-in. widths, in 100-yd-and-larger rolls with protective interliner. Price to 499 yd is $1.18/sq yd; in production quantities of 10,000 yd or over, 70¢/sq yd. **Rubber & Asbestos Corp., 225 Belleville Ave., Bloomfield, N. J.**

Circle 32, inside back cover

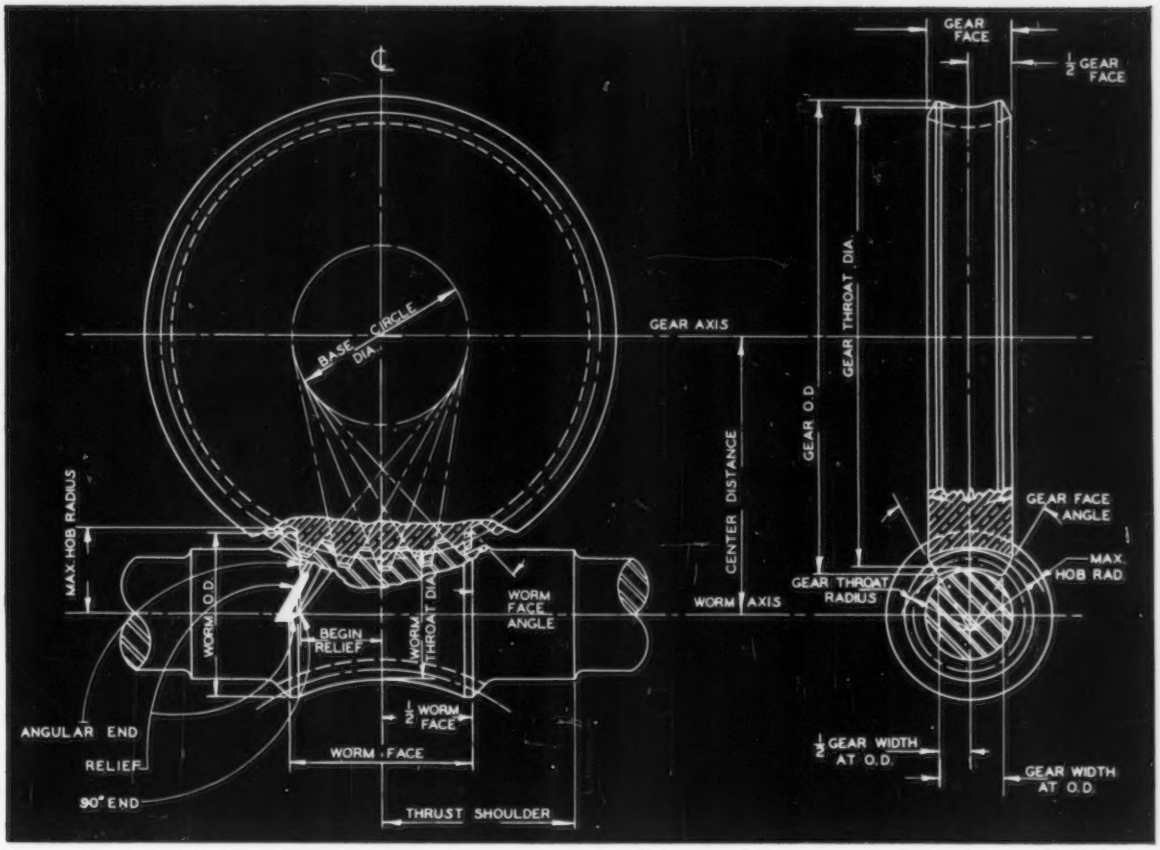


Oil-immersed circuit . . .

is used in this force-balance differential pressure transmitter. Range changes can be made and zero adjustment is external. Transmitter operates to 1500-psig working

(Continued on page 114)

WORM GEAR DESIGN... *Bulletin #200*



Bulletin 200 has 20 pages crammed with 38 formulae, such as the Formula for Class I AGMA Horsepower Rating:

$$P = K_s K_m K_v \frac{n}{mg}$$

Step-by-step instructions, with typical examples, enable you to quickly determine the size worm gearset you need to meet any horsepower and service required.

You can calculate the bearing loads and sizes needed for the worm and gear shafts.

You can check the worm root stress and gear tooth stress.

Efficiency is charted against helix angle with modifications for required speed so you can quickly determine efficiency.

One quick look at the drawing above will convince even the uninitiated that no other worm gearset has so many teeth in contact. No other worm gearset is so simple to design and rate. No other worm gearset will carry so much load in so little space with so little weight.

Now, Bulletin 200 provides complete design and application data on space-saving double-enveloping worm gearing. Ask for it without obligation.

CONE-DRIVE GEARS DIVISION MICHIGAN TOOL COMPANY

7171 E. McNichols Road • Detroit 12, Michigan • Telephone: TWinbrook 1-3111

DOUBLE-ENVELOPING WORM GEARSETS

DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS

DOUBLE REDUCTION WORM GEAR SPEED REDUCERS

DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS

Worcester's New Econ-O-"Miser" Ball Valve* is BOTH

VALVE and UNION

The costs of a union and installing it are eliminated. Add to this the longer operating life of the Econ-O-"Miser", the time and materials savings of *in-line maintenance*, and you get performance unmatched by *any* valve at *any* price.

The Econ-O-"Miser" is available in Bronze, Aluminum, Aluminum Bronze, Forged Carbon Steel, types 303 and 316 Stainless Steel. Seat and seal materials available: Teflon, Buna-N and Neoprene (others available on request.)

The many combinations of body and seat seal materials allow handling of exceptionally wide range of media.

Other Outstanding Features

- Compact for ease of installation
- Positive leakproof shut-off
- **In-line maintenance** permits quick, easy inexpensive repairs
- Two-way flow allows application of pressure or vacuum to either side of valve
- Quarter turn operation — readily adaptable to remote control
- Visual determination of OPEN — CLOSED positions — No manual check needed
- Round flow through the valve — minimum pressure loss and turbulence
- "Wiper-action" of resilient seat against ball eliminates abrasive wear due to foreign materials in media . . . assures leak-proof seal . . . long operating life

* Pat. Pending

Write for full particulars

WORCESTER VALVE CO., Inc.

18 Parker Street, Worcester, Mass.

New Parts and Materials. . . . . continued

pressure with overrange protection. Calibration stability under changing temperature or pressure conditions is exceptional. Construction permits removal of unit without disconnecting flanges from the process piping. All-metal transmitter is furnished with a corrosionproof fiber glass cover. **Fischer & Porter Co., 520 Jacksonville Rd., Hatboro, Penna.**

Circle 33, inside back cover

Translucent master sheet . . .

for silver-transfer photocopying, can be used for making reproductions in quantity at low cost by diazo or blueprinting. It can copy every type of original, opaque or two-sided. Paper is thinner than the standard 0.005-in. sheet and more transparent than the vellum it replaces. The paper is treated to produce clear black and white reproductions. **Peerless Photo Products, Inc., Shoreham, N. Y.**

Circle 34, inside back cover

Two-channel oscilloscope . . .

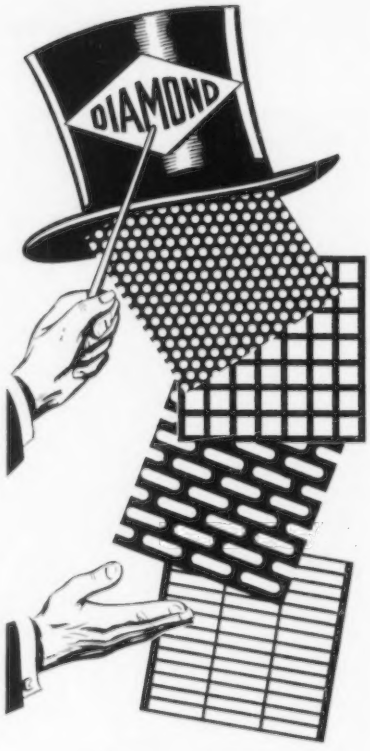
is a test instrument for lab work benches. Direct readings are possible for vibration and transient recording beyond the range of the usual direct or geophysical recording. The unit features 2-millisec deflection time and a sensitivity of 5 mv/cm, made possible in part by a transistorized amplifier. This also permits high stability and compact size. Unit is priced at $1,145. **Offner Electronics, Inc., 5320 N. Kedzie Ave., Chicago.**

Circle 35, inside back cover

Counterbalanced table . . .

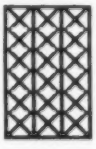
is fully adjustable and is combined with a drafting machine. The 40 x 60 in. table can be positioned manually from hori-

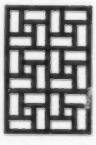
(Continued on page 116)



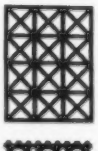
Top-Hat Quality IN Perforated Metal

The popular Diamond Perforated-metal patterns shown above are only a few of the many illustrated and described in our 32-page Catalog No. 39. All of these standard patterns are available in a wide range of unit-opening sizes and we are always equally pleased to quote on original designs of any type or size.

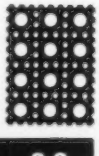




Catalog 39 also illustrates and describes our high-quality lines of *Ornamental Cane*, Perforated-Metal Sheets for Accoustical installations and Heavy-Duty Architectural Grilles. Write, today, for a free copy.



Correspondence is especially invited regarding ANY requirement for perforated-metal panels or parts. We are equipped to fabricate special sections to any desired extent and welcome opportunities to make money-saving suggestions.



DIAMOND MFG. CO.
WYOMING WILKES-BARRE AREA PA.
West Coast Plant,
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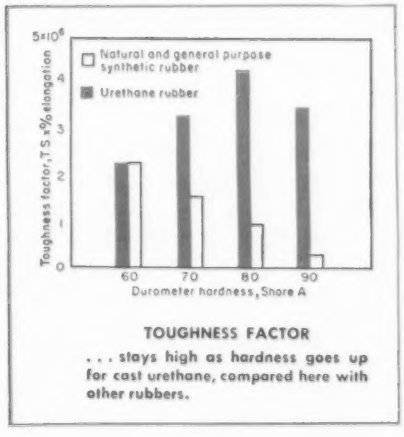
17915 So. Figueroa St., Gardena, California
Los Angeles Area

URETHANE RUBBER

fits the tough assignments...

...and fills the property gap between rubbers and metals



TOUGHNESS FACTOR

. . . stays high as hardness goes up for cast urethane, compared here with other rubbers.

Mobay supplies basic chemicals and technology required for the manufacture of urethane rubber—latest addition to the growing list of urethane products for industry.

Urethane rubber is a new, chemically-engineered casting material developed for use in industrial parts where high load-bearing and long-wearing properties are critical requirements. It needs no waxes, clays, fibers or fillers such as are used in other rubbers to add functional properties lacking in the basic material. In urethane rubber, the molecular composition of the basic compound itself is modified to "build in" the range and combination of desired properties. You can specify—and get—the exact durometer, degree of elasticity, tensile strength, abrasion resistance and electrical properties you need.

What does this mean to you? If you are responsible for the selection of materials for your company's products, it means urethane rubber has opened up a broad new area on your materials selector charts. If you are a manufacturer, or responsible for production or maintenance costs on heavy-duty equipment, urethane rubber means economy because of the ease with which it may be cast into parts having difficult undercuts, slots, inserts, threads or other complex design features.

Get the full story on how urethane rubber can fit into your product's future. Write today, briefly outlining your area of interest. Technical data and sources of fabricating assistance will be forwarded promptly.

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Dept. P-5, Pittsburgh 34, Pa.

MOBAY
First in Urethane Chemistry

3 JOHN CRANE "Pressed-In" SEALS

for economy, quick installation and life-long performance in all types of service

TYPE 11-A

Synthetic Rubber Bellows • Small shafts to ¾ in.

Services: hot or cold water, oil, gasoline, kerosene and other liquids non-injurious to synthetic rubber.

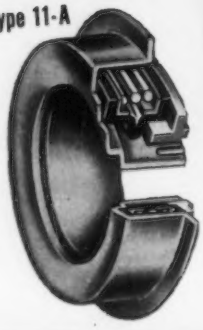
Pressures: up to 50 psi.

Temperatures: −65°F. to +220°F. Special construction to +300°F.

Construction Data: Packaged unit. Retainer does not contact shaft, permitting operation at a high rpm. One size can be used for several shaft sizes. Bellows encloses spring and metal parts to prevent contact with medium being sealed.

TYPE 6-A

Synthetic Rubber Bellows • Interchangeable with Type 11-A



Services: hot or cold water, oil, gasoline, soapy and other liquids non-injurious to synthetic rubber.

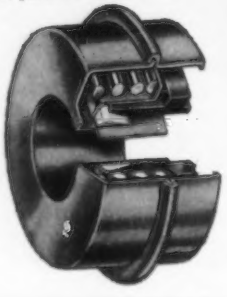
Pressures: up to 75 psi.

Temperatures: −65°F. to +220°F. Special construction to +300°F.

Construction Data: Similar to Type 11-A. Does not contact shaft, permitting operation at high rpm. One size can be used for several shaft sizes. Spring and metal parts available in stainless steel or bronze.

TYPE 9-A

Sealing Members Made of Teflon* • Engineered for the particular application



Services: all chemicals, solvents, oils, corrosives and gases, hot or cold.

Pressures: to 150 psi. Balanced construction to 750 psi.

Temperatures: −120°F. to +500°F.

Construction Data: Packaged unit. Furnished in metallurgical specification best suited to the application. Chemically-inert Teflon wedge ring closely fits inner sleeve of retainer and is machine-mated to carbon sealing washer.

Contact "John Crane" for the particular seal best suited to your application. Request bulletin giving full information on "John Crane's" complete line of mechanical seals.

*DuPont trademark

JOHN CRANE CRANE PACKING COMPANY

38 YEARS INDUSTRIAL PROGRESS

zontal to an 88° vertical. Table can be dropped to floor level. The parallelogram drafting machine has 10 ball bearings that eliminate band adjustment and allow the machine to return to zero base line. It is held by two cone pivots at the top of the anchor and may be lifted away from the board, eliminating smudging. Drafting head is equipped with scale and vernier. A built-in cross-hatching device can be used at any angle and permits spacing from 0 to ⅛ in. **Ozalid Div., General Aniline and Film Corp., 3 Corliss Lane, Johnson City, N. Y.**

Circle 36, inside back cover

Spur gear kits . . .

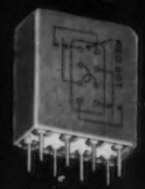
with precision I, II, or III gears are designed for use in breadboards, mockups, experimental and prototype applications. Available in 48, 64, 72, 96 and 120 pitches. Gears are stainless steel and aluminum. Kit comes in a felt-lined case and has a variety of gears, shafts, collars, couplings, clamps and other miscellaneous items. **PIC Design Corp., sub. Benrus Watch Co., Inc., 477 Atlantic Ave., E. Rockaway, N. Y.**

Circle 37, inside back cover

Capillary controlled pen . . .

permits use of ordinary ink on any drawing surface. The instrument will draw a line over 1000 ft long without refilling. Rubber-base, colored or India inks, and water colors may also be used on any medium, including paper, acetate, cloth, Mylar, or glass. Five interchangeable, adjustable ruling nibs allow a range of line widths from hairline to ⅛ in. **Ozalid Div., General Aniline and Film Corp., 2 Corliss Lane, Johnson City, N. Y.**

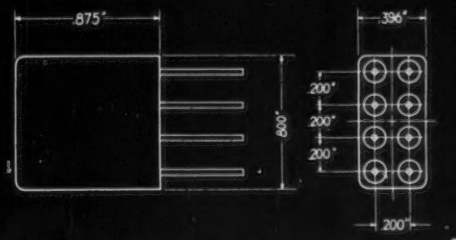
Circle 38, inside back cover



Smaller than a postage stamp!

(except in thickness, of course)

—the *new* CLARE *Type F* RELAY



SPECIFICATIONS:

Ambient Temperature	—65° C to +125° C.
Shock	50 Gs for 11 milliseconds.
Vibration	5-75 cps at maximum excursion of ⅛-inch, 75-2000 cps at 20 Gs acceleration.
Dielectric Strength	Sea level—1000 volts rms between terminals and frame, and between adjacent circuits; 750 volts rms between contacts of a set. At 80,000 ft., 350 volts rms.
Insulation Resistance	1000 megohms minimum at 125° C.
Coils	Coils up to 10,000 ohms available for a wide range of voltages or currents.
Nominal Operating Power	250 milliwatts.
Pickup Time	3.5 milliseconds nominal.
Dropout Time	1.5 milliseconds nominal.
Contact Arrangement	2 pdt (2 form C).
Contact Rating	3 amps resistive at 28 volts d-c or 115 volts a-c; also for low-level applications.
Contact Resistance	0.050 ohm maximum.
Contact Life	500,000 operations minimum at 2 amps; 100,000 operations minimum at 3 amps.
Enclosure	Hermetically sealed, filled with dry nitrogen at 1 atmosphere pressure.
Mounting	All popular mounting arrangements available.
Terminals	Printed circuit; solder; plug-in (matching socket available). Variations of printed-circuit terminal length on 1/10-inch grid spacing available.
Weight	17 grams.
Military Specifications	MIL-R-25018; MIL-R-5757C, except as to contact overload.

This new hermetically sealed relay—no bigger than a postage stamp—is Clare's response to the insistent demand of the military and of industry for a smaller and lighter relay stalwart enough to withstand extremes of temperature, heavy shock, and severe vibration, yet fast and more than moderately sensitive.

Without any assertions of superior design, materials or workmanship, the factual specifications at the left tell how closely this relay is geared to the needs of today's advanced circuit designers. Important to many engineers will be the fact that the contacts—rated at 3 amperes—are proven also for low-energy-level circuit applications. Designers of printed-circuit layouts will note that the terminal arrangement is nicely suited to 1/10-inch grid spacing.

For complete information send for Bulletin 124. Write or call: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: CLARELAY.

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FIRST in the industrial field

...for a standard line of motors adaptable to hundreds of applications

YOU CAN ALWAYS

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Fractional H. P. Motors

1/40 H. P. to 1/1100 H. P.

General Industries' standard line of motors is adaptable, with slight variations, to literally thousands of applications. This means that your motor requirements can most likely be met without additional time-consuming engineering.

If you are currently using fractional horsepower motors, or are planning a product that calls for their use, phone or write General Industries. We'll gladly make recommendations — without obligation.

MODEL A
2-pole, shaded pole AC Induction Type

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MODEL E
4-pole, shaded pole AC Induction Type

MODEL D
4-pole, 4-coil shaded pole AC Induction Type

Write for Complete Specifications and Quantity Price Quotations TODAY!

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CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 125.

SILENT CHAIN DRIVES—Book 2425, 88 pp. With engineering data and illustrations. Has tables of service factors, ratings, chain-length and center-distance computations. Pre-engineered stock drives are listed in a 16-pp section; a 22-pp section outlines procedure for selection of engineered drives. Another section on drive components lists available chain widths, chain and wheel dimensions, wheel tolerances, materials and other data. Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1.

Circle 39, inside back cover

TEFLON HOSE AND REUSABLE FITTINGS—Catalog supplement, 4 pp. Describes fitting designed for flexible, braided-wire hose with a Teflon innercore. Design specs of both are given with suggested applications and ordering information. Titeflex, Inc., Hendee St., Springfield 4, Mass.

Circle 40, inside back cover

PILLOW BLOCKS AND FLANGE BLOCKS—Catalog BU-101-A, 12 pp. Illustrates and describes line of bearing units lubricated for life and permanently sealed against contamination. Browning Mfg. Co., Maysville, Ky.

Circle 41, inside back cover

FULL-FLOATING SHAFT COUPLINGS—Brochure 98, 4 pp. Describes applications and types of couplings used to connect shafts spaced far apart. With photos and schematics. Thomas Flexible Coupling Co., Warren, Penna.

Circle 42, inside back cover

COMBUSTION ENGINE POWER UNIT—Catalog MS-1247, 8 pp. Gives operating characteristics and specs. Unit components are illustrated, and also included is a list of special equipment available to expand the versatility and use of the engine. Allis-Chalmers Mfg. Co., Milwaukee 1.

Circle 43, inside back cover

CUSTOM RUBBER MOLDINGS — Folder, 4 pp. Describes some of services available. Rubber-parts production facilities are outlined and typical parts illustrated. E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33.

Circle 44, inside back cover

VIBRATION CONTROL MOUNTINGS—Bulletin K4D, 4 pp. Presents 15 different types of machinery mountings that utilize steel springs, rubber and cork, singly or in combination. Shows installation photos. Gives engineering specs and performance data for entire line. Korfund Co., Inc., 48-19C 32nd Pl., Long Island City 1, N. Y.

Circle 45, inside back cover

MINIATURE CLUTCHES, BRAKES—Catalog 957, 28 pp. Covers the complete line of miniature and subminiature electromagnetic clutches and brakes. Included for each type is cutaway drawing, engineering data, schematics, dimensional data, min-performance curves, oscilloscope readings and other technical information. Also, photos and description of company facilities. Autotronics, Inc., Rt. 1, Box 812, Florissant, Mo.

Circle 46, inside back cover

PLUG GUIDE—Catalog, 40 pp. A checklist for selecting proper connector considers size, number and style of contacts, mounting space, coupling methods, insulation and environmental conditions. Also shows photos of representative connectors with information on application. Cannon Electric Co., 3208 Humboldt St., Los Angeles 31.

Circle 47, inside back cover

ELECTRICAL CONTACTS — Catalog 601, 4 pp. With tables of materials and properties. Applications are also included. Has dimensional drawings. Gibson Electric Co., Old William Penn Highway, Delmont, Penna.

Circle 48, inside back cover

PNEUMATIC CONTROLLER — Catalog 53P-4000, 12 pp. Discusses motion-balance pneumatic controllers with regenerative feedback circuit. With cutaways, schematics, and dimensional drawings. Fischer & Porter Co., 489 Jacksonville Rd., Hatboro, Penna.

Circle 49, inside back cover

SPIRAL WOUND METAL GASKETS—Bulletin AD-104, 12 pp. Design factors are discussed, also types available for specific applications. Sizes are listed and charts for suggested sizes in relation to

(Continued on page 118)

all the EXTRAS are standard with T-J Spacemaker CYLINDERS

Member of the National Fluid Power Association

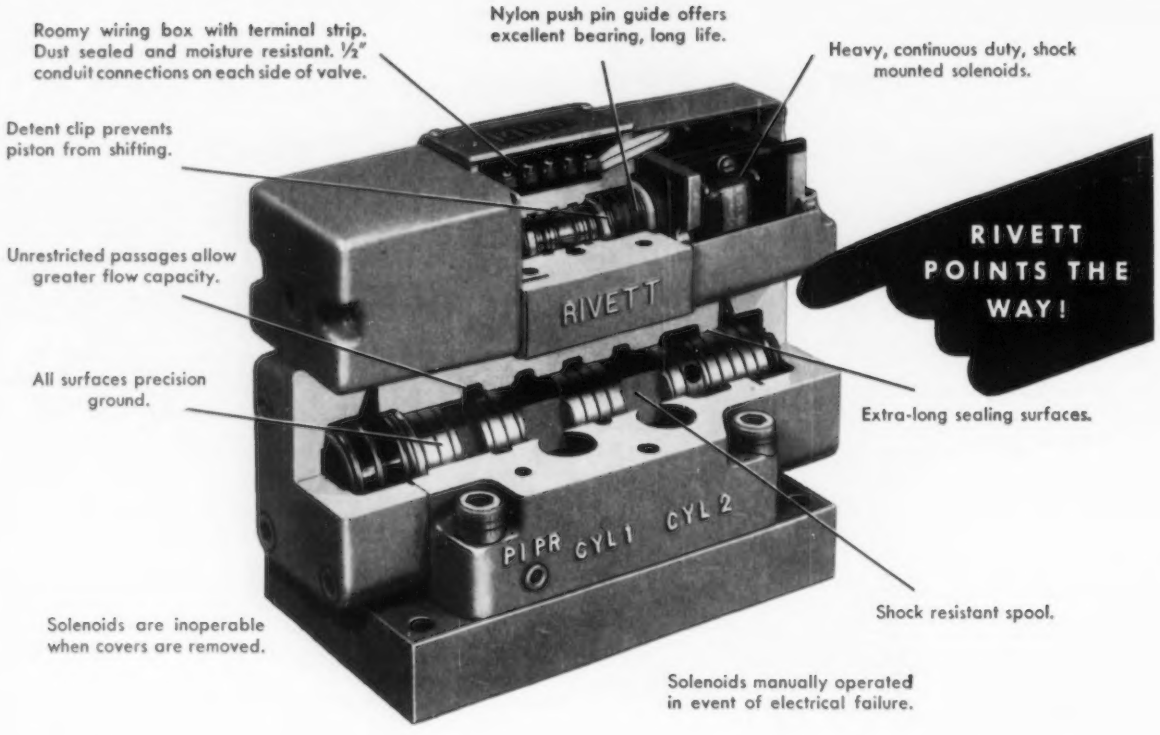
- **NEW** *exclusive* ingenious cushion designs . . . Super Cushion Flexible Seals for Air . . . New Self-Aligning Master Cushion for Oil.
- **STRONGER** than outmoded tie rod design, proven through actual tests. No tie rods to stretch.
- **SOLID STEEL HEADS** throughout the full line.
- **COMPACT DESIGN** eliminates tie rods, increasing the strength and reducing mounting space required, providing extra room for adjacent equipment.
- **HARD CHROME PLATED** body bores and piston rods . . . assure you of long trouble-free service. (Standard at no extra cost.)
- **METALLIC ROD SCRAPER,** not just a wiper, actually removes foreign matter from the rod.
- **PILOTED PACKING GLAND** with extra long bearing. Additional strength and support to the piston rod.
- **OIL** pressure to 750 p.s.i. AIR to 200 p.s.i.

DELIVERY OFF THE SHELF!

You *save 40% space* when you switch from outmoded tie rod cylinders to the T-J Spacemaker! It's stronger, too! Fits right into automation programs in countless plants. Delivers top performance and dependability with a big *plus* in advanced features. Wide range of styles, capacities . . . reduces man-hours and costs in all kinds of push-pull-lift operations. Off-shelf delivery in 64,000 combinations!

NEW LITERATURE—Send today for new Catalog SM56 with complete engineering details on Spacemaker line. Write The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVETORS . AIR AND HYDRAULIC CYLINDERS . CUTTERS . CLINCHORS


Roomy wiring box with terminal strip. Dust sealed and moisture resistant. ½" conduit connections on each side of valve.
Nylon push pin guide offers excellent bearing, long life.
Heavy, continuous duty, shock mounted solenoids.
Detent clip prevents piston from shifting.
RIVETT POINTS THE WAY!
Unrestricted passages allow greater flow capacity.
All surfaces precision ground.
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P PR CYL 1 CYL 2
Shock resistant spool.
Solenoids are inoperable when covers are removed.
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High Flow Capacity!

Rivett's New Solenoid Pilot Operated Hydraulic 1" Valve Is Rated at 28 G.P.M. and the 1½" Size At 82.5 G.P.M., At 15 Ft. Per Sec. Velocity.

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- 3000 P.S.I. Operation for Multi-Million Cycles
- Optional: Built-in Speed Controls
  Explosion Resistant
  Solenoid Enclosures

Forget about back pressure by specifying Rivett 6600's for service up to 3000 P.S.I. Reduce inventory! Select off the shelf: 2 basic sizes fit ⅜", ½", ¾", 1", 1¼" and 1½" I.P.S. Single and double solenoid. 7 spool designs. Meet *all* J.I.C. requirements.

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THE BETTER YOU KNOW HYDRAULICS THE BETTER YOU LIKE

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"100"
HYDRAULIC VALVES

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TO ENGINE USERS EVERYWHERE----

THE FAMOUS LYCOMING AIR-COOLED INDUSTRIAL ENGINE LINE, TWO AND FOUR CYLINDERS, WILL NOW BE MADE BY HERCULES MOTORS CORPORATION. THIS FORWARD STEP ENABLES HERCULES TO OFFER A PROVED, DEPENDABLE AIR-COOLED ENGINE IN ADDITION TO ITS WATER-COOLED ENGINES, GIVING USERS A WIDE SELECTION OF VALVE-IN-HEAD ENGINES IN THE DISPLACEMENT RANGE FROM 88 TO 339 CU. IN.

THE HERCULES REPUTATION FOR RELIABILITY, QUALITY MANUFACTURING AND ENGINEERING, PLUS THE COMBINED DISTRIBUTOR ORGANIZATIONS FOR BOTH LYCOMING AND HERCULES, ASSURE PRESENT CUSTOMERS AND POTENTIAL USERS MUCH BROADER SPREAD OF IMPROVED SERVICE FACILITIES.

FULL SCALE PRODUCTION OF THE LYCOMING AIR-COOLED ENGINE AT HERCULES CANTON OHIO PLANT SCHEDULED FOR EARLY 1958. YOUR INQUIRIES WILL BE APPRECIATED AND WILL BE PROMPTLY AND COURTEOUSLY ANSWERED.

W.L. PRINGLE, PRESIDENT
HERCULES MOTORS CORPORATION
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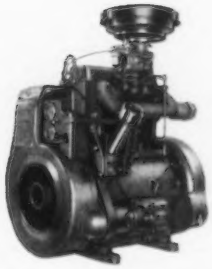
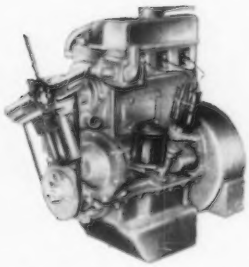
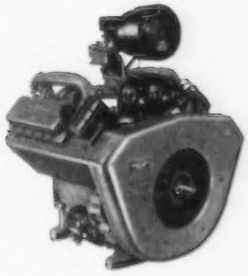


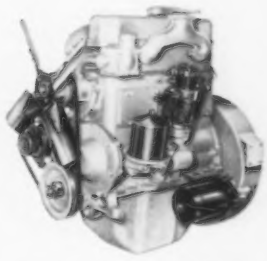
Lycoming-Design Hercules Two Cylinder Air-Cooled Industrial Gasoline Engine, Displacement 88 cu. in.



Hercules Three Cylinder Water-Cooled Gasoline (or Diesel) Engine, Displacement 130-149-169 cu. in.



Lycoming-Design Hercules Four Cylinder Air-Cooled Industrial Gasoline Engine, Displacement 176 cu. in.



Hercules Four Cylinder Water-Cooled Diesel (or Gasoline) Engine, Displacement 173-198-226 cu. in.

Hercules engines are also available in six cylinder 260, 298 and 339 cu. in. valve-in-head water-cooled types.

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These are actual size advance stampings, which saved production costs.

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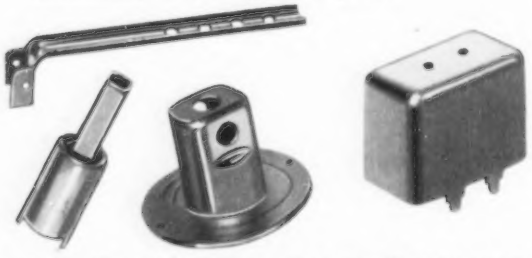
when you engineer in stampings. Save on material, labor and assembly costs. Here are just a few of the Advance Stampings, which have been fabricated in various materials to meet tolerance specifications, delivery and price.



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How to keep informed on the "with what" part of your business

AT YOUR FINGER TIPS, issue after issue, is one of your richest veins of job information – advertising. You might call it the "with what" type – which dovetails the "how" of the editorial pages. Easy to read, talking your language, geared specifically to the betterment of your business, this is the kind of practical data which may well help you do a job quicker, better – save your company money.

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You, too, have a big stake in the advertising pages. Read them regularly, carefully to keep job-informed on the "with what" part of your business.

McGRAW-HILL PUBLICATIONS

pressures sealed are included. The Garlock Packing Co., 415 Main St., Palmyra, N. Y.

Circle 50, inside back cover

AUTOMATIC RETURN CYLINDERS—Bulletin, 4 pp, and price list. Describes cylinders with photos and dimensional drawings. A. K. Allen Co., Inc., 255 E. Second St., Mineola, N. Y.

Circle 51, inside back cover

TOTAL TEMPERATURE PROBES — Bulletin 25721, 20 pp. General description is followed by descriptions of specific models. Outline, mounting and electrical-connection drawings, diagrams of the sensing element, and performance charts and curves supplement the bulletin. Rosemount Engineering Co., 9424 Lyndale Ave., S., Minneapolis 20.

Circle 52, inside back cover

WIRE PRODUCTS — Folder, 6 pp. Guide to ferrous and nonferrous wire products. Includes a wire-gage table. H. K. Porter Co., Inc., Riverside-Alloy Metal Div., Riverside, N. J.

Circle 53, inside back cover

HYDRAULIC AND PNEUMATIC CYLINDERS—Catalog 657S, 4 pp. Describes heavy-duty air and low-pressure hydraulic cylinders. With dimensional drawings and tables, pressure capacities and cutaway drawings. W. G. Rovang & Associates, Inc., 1945 N. Columbia Blvd., Dept. PRE, Portland 17, Ore.

Circle 54, inside back cover

SILICONE-COATED PAPER—Brochure S-601, 4 pp. Properties and performance of papers treated with silicone coatings are given. Also includes samples of coated kraft, glassine and parchment. Dow Corning Corp., Midland, Mich.

Circle 55, inside back cover

CONTROL SWITCHES—Bulletin, 2 pp. Describes force control switches. Lists specs and prices. W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.

Circle 56, inside back cover

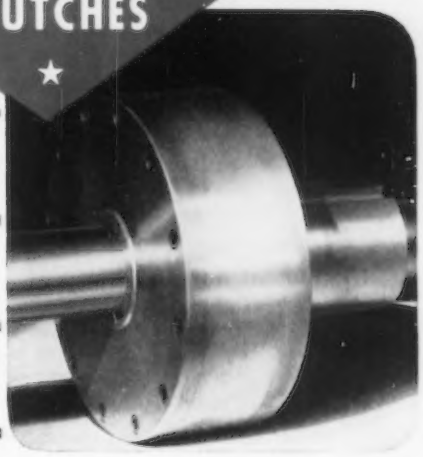
HIGH-TEMPERATURE ALLOYS — Booklets, 28 pp. each. Properties of a wrought cobalt-base alloy and a nickel-base alloy available in both wrought and cast form. Both booklets contain sections on physical properties, short-time tensile data and stress-rupture and creep data. Describes methods for welding, forming and machining. Haynes Stellite Co., div. Union Carbide Corp., 30-20 Thomson Ave., Long Island City 1, N. Y.

Circle 57, inside back cover

SILICONE CATALOG—Reference guide, 16 pp. Describes over 150 commercially

(Continued on page 125)

FOR POWER CONTROL DESIGNS USE
HILLIARD
Over-Running
CLUTCHES
★



1 LONG LIFE because the rolls have no localized wear points.

2 NO JAMMING even after long wear.

3 ACCURATE because of individual spring pressure on each roll.

4 RENEWABLE CAM SURFACES for increased life without machining or new parts.

50 YEARS of satisfactory service proves you can depend on Hilliard Over-Running Clutches and Couplings for long service on—

- DUAL DRIVES for pumps, fans, blowers and boiler stokers. (Many installations have a record of over 20 years without repair.)
- TWO SPEED DRIVES for dry cleaning machines, laundry equipment, conveyors, paper processing machines, slitters, forming rolls and automatic machinery.
- RATCHET ACTION for printing press ink rolls, coal feeders, press feeds, honing machines, bakery equipment and conveyors.
- BACK STOP SERVICE on textile machines, speed reducers, elevating conveyors and in combination with ratchet feeds.
- WRITE TODAY FOR BULLETIN 231 WITH COMPLETE INFORMATION.

OTHER HILLIARD CLUTCHES:

SINGLE REVOLUTION CLUTCHES for automatic accurate control—electrical or mechanical—of intermittent motion, indexing, cycling and cut-off. Ask for Bulletin 239.

SLIP CLUTCHES for overload protection, or constant torque and to provide constant tension and permit speed variation on rewind stands. Ask for Bulletin 300.

HILLIARD - TWIFLEX CENTRIFUGAL COUPLING for smooth, easy starting of any load automatically with overload protection and ability to accommodate shaft misalignment. Ask for Bulletin CE-3.

★ CONSIDER AUTOMATION-INVESTIGATE THESE PRODUCTS

THE HILLIARD Corporation
MANUFACTURING CLUTCHES FOR OVER 50 YEARS
101 W. Fourth St., Elmira, N. Y.

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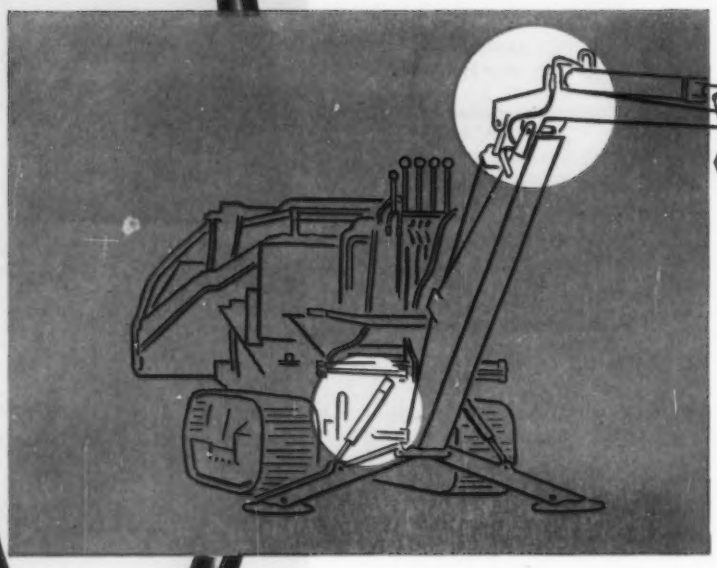
...for greater dependability...LONGER

LINEAR KEEPS THE "BITE"
IN A BACK-HOE
with Roto-Mold "O" Rings



The "bite" of a back-hoe—or any of the countless other small and large earth moving machines—depends on the use of precision seals that can retain hydraulic pressure in pumps, controls and actuating cylinders under all conditions. LINEAR Precision Roto-Mold "O" Rings provide the dependability that keeps expensive equipment operating longer at peak efficiencies—around the clock.

LINEAR'S extensive experience in working with all types of elastomers enables the selection of materials that can stand up under extreme temperature variations, continuous exposure to abrasive dirt and dust, and against surge pressures which may fluctuate to as much as 50,000 psi.

The exclusive Roto-Mold process makes possible precision "O" rings—physically better—free from foreign inclusions and flash. Another plus is scheduled deliveries at maximum economy.

No matter what your sealing problem may be—call on LINEAR or one of its agents for engineering assistance—and be sure to specify LINEAR Roto-Mold "O" Rings.

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available silicone products made by the firm. Has charts, tables, graphs and property and performance data. Illustrated and cross-indexed. Dow Corning Corp., Midland, Mich.

Circle 58, inside back cover

LUBRICATING EQUIPMENT—Catalog 10, 32 pp. Describes equipment, has dimensional drawings. Gives specs and operational information. Oil-Rite Corp., 2318 Waldo Blvd., Manitowoc, Wis.

Circle 59, inside back cover

EXPANDED METALS—Brochure, 4 pp. Copper, brass, aluminum, Monel, stainless steel and carbon-steel mesh for decorative and structural applications are described and illustrated. Designers Metal Corp., Harvey, Ill.

Circle 60, inside back cover

ELECTRICAL CONTROLS — Bulletin 106, 12 pp. Explains applications of the all-purpose controls suitable for use with virtually any detectable variable. With specs, schematics, and ordering information. Assembly Products, Inc., Chesterland, Ohio.

Circle 61, inside back cover

INDUSTRIAL VINYL HOSE, ACCESSORIES—Catalog H-52, 8 pp. Engineering data, specs and performance data on vinyl-plastic hose, hose assemblies and fittings. Hofmann Engineering Co., 5601 S. Crawford Ave., Chicago 29.

Circle 62, inside back cover

INDUSTRIAL FASTENERS — Catalog, 8 pp. Engineering data is provided on line of special fasteners. Dimensional drawings, specs and important features are included. Simmons Fastener Corp., North Broadway, Albany 1, N. Y.

Circle 63, inside back cover

SUBMINIATURE CALIBRATION SYSTEM—Bulletin BBU-A, 2 pp. Describes and illustrates system for use with strain gages, accelerometers or resistance-type transducers to control, balance and automatically calibrate up to 24 transducer channels. Specs are given. B&F Instruments, Inc., 4732 N. Broad St., Philadelphia 41.

Circle 64, inside back cover

Letterhead Requests Only

The manufacturer that published following literature asked that requests for copies be made on company letterheads.

FASTENERS—Fact file, 42 pp. Contains design and purchasing information on rivets and riveting machines. Includes an evaluation questionnaire and a rivets-standards chart. Judson L. Thompson Mfg. Co., Waltham 54, Mass.

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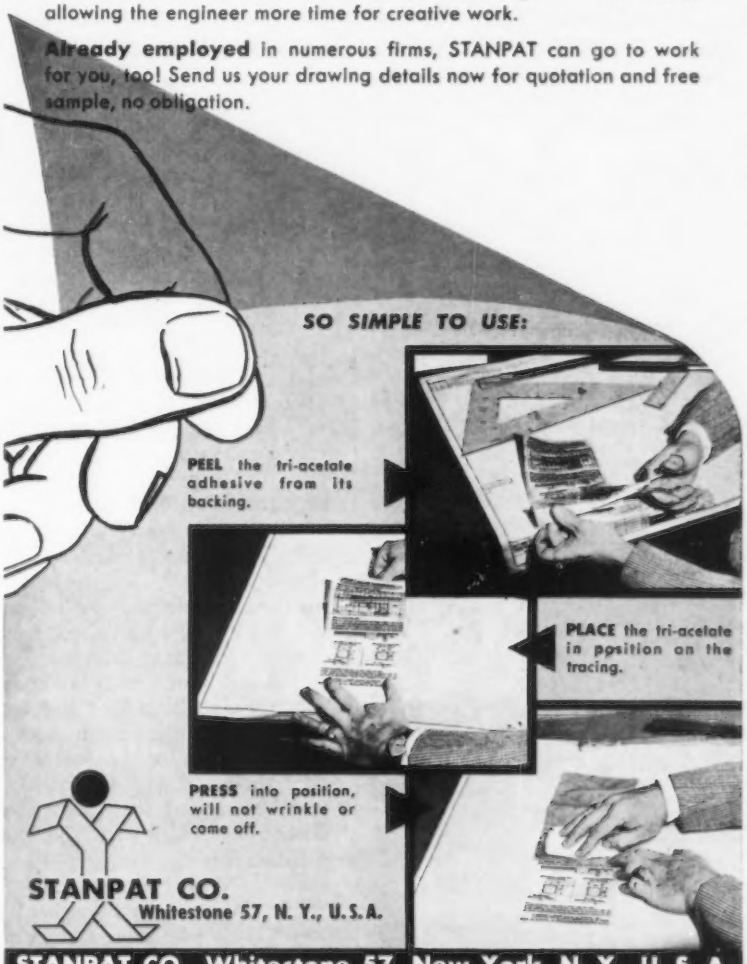
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Inspiration is Only 1%

Scientific discovery, judging from sensational popular biographies, is apparently often pure inspiration. Archimedes leaps from his bath with a new law, Newton rubs his apple-bumped head and has another, Descartes discovers geometric principles in bed, Darwin solves the riddle of evolution while reading a passage in Malthus, Kekule visualizes the closed carbon ring atop a London bus, Einstein solves Michelson's puzzle in the Swiss patent office.

These discoveries are supposed to have come out of the blue. They didn't. As Edison once said, they were "99% perspiration, 1% inspiration." They required a whole series of preliminary steps. In each case, the mind of a genius took a batch of apparently unrelated facts and impressions and put them together.

Actually, each scientific breakthrough is preceded by consideration of a vast accumulation of data. The ordinary mind has access to the facts, may even consider them, but it rarely combines them in unconventional ways or examines them from unexpected points of view. The unconventional thinker sees things "in the round" and comes to a new discovery almost intuitively. Perhaps he proves his theory by plodding, logical steps—but this is only a final check (and to convince less-gifted thinkers).

The real labor here is in absorbing data. It must be studied and understood, thought about again and again, because flashes of inspiration can't occur in a vacuum. Only ten facts may be necessary for a particular invention—but which ten? The 1% inspiration is in this final step—the only step that shows.

Thus it has been throughout history. Those who express amazement at Oriental peoples showing as much scientific skill as Occidental should remember that our scientific knowledge is Oriental in origin. Our decimal system existed in Egypt six thousand years ago. The Sumerians had a highly technical system of accounting and a good knowledge of astronomy five thousand years ago. Egyptians established the 365-day calendar in 4241 BC. Babylonians accumulated observations of planets and lists of stars for astrology then could even predict eclipses.

From these peoples, with a thousand-year lapse that no one can explain, the Greeks borrowed observations and crude theories that became the basis of the 500-year Greek civilization. This was essentially Western, rather than Eastern, in character. Then Greece was conquered by Rome, and the Romans were so afraid of pure or basic research that they discouraged anything but applied research. As a result, Roman science at its best was only a pale imitation of the Greek. The fire was dying, smothered by failure to spread the frontiers of knowledge as Rome spread her geographical ones.

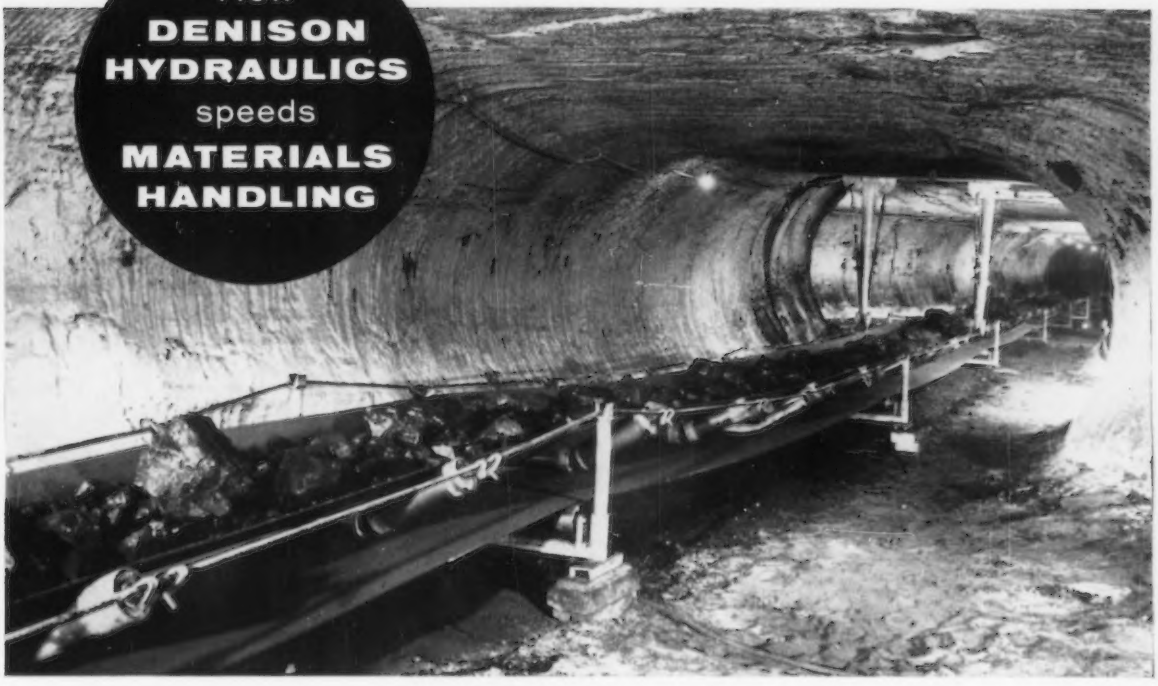
Then came Mohammed at Mecca. In one short decade, 622-632, he united the Arab tribes and gave them a single-hearted fervor which pushed them on to conquer their world. The Muslims (followers of the Prophet) took Damascus in 635, Jerusalem in 637, Egypt in 641, Persia in 642, Spain in 710-712. Of these, the Persian conquest was most important, because in Persia there existed a great curiosity, a spirit of basic research, which was swept along by the Muslim fanaticism. And the Islam civilization flowered incredibly fast. It combined Semitic monotheism and morality, taught by the Prophet; Greek and Sanskrit learning, taught by Persian tutors; arithmetic, algebra, trigonometry and chemistry from the Hindus; logic, geometry, astronomy and medicine from the Greeks. It mined the Greek storehouse of knowledge as the Romans never had, and translated it into Arabic, spreading it from Baghdad east to India and west to Spain.

No Arab ever rose to the heights of Greek genius—none compared to Archimedes or Appolonius or Hippocrates. But the Arabs did produce, in two centuries, a tremendous civilization which made up in quantity for what it lacked in quality of development. Algebra and trigonometry were expanded and built up, geometry was

(Continued on page 129)

How **DENISON HYDRAULICS** speeds **MATERIALS HANDLING**

BELT-LOADS OF COAL FLOW SMOOTHLY *on Goodman "Ropex" conveyor applying new design concept which supports loaded belt on chain-linked suspended idlers. Denison hydraulic power drives the "Ropex" efficiently at low cost.*



Here's how the **GOODMAN** "Ropex"® conveyor rolls vibration-free on **DENISON** hydraulic power

Faced with the problem of designing drives and controls for coal mining machines that would give smooth, flexible, vibration-free power—Goodman Manufacturing Company found the answer . . . a Denison hydraulic transmission system.

In developing the "Ropex"—an extensible belt-supported conveyor—Goodman designers incorporated four rugged Denison Axial Piston Pumps, four Fluid Motors and relief valves.

"ROPEX" SELF-PROPELLED CONVEYOR *developed by Goodman Manufacturing Co., Chicago, incorporates 4 Denison Axial Piston Pumps, 4 Fluid Motors and relief valves in its smooth, hydraulic transmission. Shown above, "Ropex" tail section with position of Denison hydraulic motor and valves indicated.*

The "Ropex" consists of two basic sections: The *head end section* discharges on the secondary belt and holds 100 feet of belt storage . . . paying in and out as the tail end moves. The *tail end section* stores 650 feet of wire rope (which supports belt rollers) on each rope drum. Ropes are kept tight, when winding or unwinding, by two hydraulic motors.

In the tail end, two Denison Fluid Motors operate the tractor treads—and are controlled by two Denison Pumps for low-speed tramming or moving backward and forward. Two other Denison Fluid Motors independently drive gearing of the rope drums. For high-speed moving from place to place, the two pumps which furnish power for the ropes are diverted to supply power for the treads.

Result: a compact "Ropex" unit that cuts moving costs . . . increases load-carrying ability with minimum spillage . . . assures continuous trouble-free operation . . . ease of control.

It's another efficient job done by Denison hydraulic power—the kind of job your Denison hydraulic specialist can help *you* do. Write Denison Engineering Division, American Brake Shoe Co., 1194 Dublin Road, Columbus 16, Ohio.

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HIGH SHOCK CRYSTAL-CASE RELAYS

2 NEW RELAYS

Crystal-Case Size! Permanent Magnet Design.
No Contact Openings. Shock: 100g. Vibration: 30g 55 to 2000 cps.

SC NON-LATCHING TYPE—This micro-miniature relay sets new standards—in design, in performance, in reliability. Yet the SC conforms to standard dimensions and circuitry and may be used to replace ordinary crystal-case relays. A permanent magnet in the structure provides *at least twice the contact pressure found in relays of comparable size*. This extra force accounts for the extremely high shock and vibration resistance shown in the specifications.

SL LATCHING TYPE—Unique magnetic latch assures positioning of armature and exceptional pressure. A 1 watt, 3 ms. pulse to either coil transfers contacts. Transfer time is only 0.5 ms. Coils are designed for continuous duty. Has the same exceptional shock and vibration characteristics as the SC.

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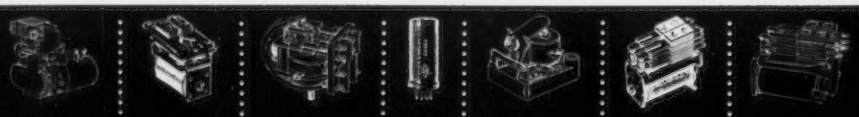

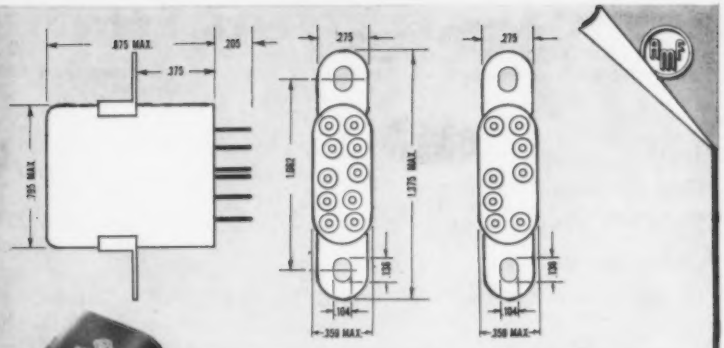

SL—dual coil latching relay. Operates on a 1 watt, 3 ms. pulse at nominal voltage. Permanent magnet latch locks the armature in either position.

SC—non-latching relay with series-connected dual coils. Operates on approximately 1 watt at nominal voltage. Coils must remain energized to hold the armature in the operate position.

SC and SL Series Engineering Data

GENERAL: **Insulation Resistance:** 10,000 megohms, min.
Breakdown Voltage: 1,000 V. RMS.
Shock: 100g.
Vibration: 30g 55 to 2000 cps.; 0.195" max. excursions from 10-55 cps.
Temperature Range: −65° C. to +125° C.
Weight: 17.5 grams (5/8 oz.).
Operate Time: 3 MS. max. with 550 ohm coil @ 24 V. DC. (SL: 630 ohm coil at 24 V. DC).
Transfer Time: 0.5 MS max.
Terminals: (1) Plug-in for microminiature receptacle of printed circuit board.
(2) Hook end solder for one #20 AWG wire.
Enclosure: Hermetically sealed.

CONTACTS: **Arrangement:** 2 Form C.
Material: Gold flashed palladium.
Load: 2 amps @ 28 V. DC, resistive; 1 amp @ 115 V. AC, resistive.
Pressure: SC—13 grams min.; SL—16 grams min.

COIL: **Power:** Approx. 1.0 watt at Nominal Voltage.
Resistance: SL—40 to 1400 ohms; SC—35 to 1250 ohms.
Duty: Continuous.

MOUNTINGS: Bracket, stud and plug-in.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC, ELECTRICAL AND REFRIGERATION DISTRIBUTORS

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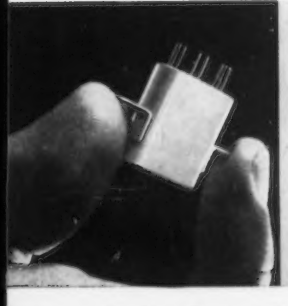

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See our catalog in Sweet's Product Design File

developed a little; astronomical observations were so extensive they helped the Reformation a thousand years later; medicine, chemistry, optics, meteorology, density measurement, geography, accounting, history—all these were expanded.

Actually, from the beginning of the eighth century to the end of the eleventh, the Arabs led mankind. Then anyone who wanted to learn science must needs do so in Arabic, as the modern scientist-aspirant must in German, English, and Russian.

During the twelfth and the first half of the thirteenth centuries, the principal job of European scholars was translation of Arabic writings into Latin. Europe was ready to emerge from the Dark Ages, and Islam, after 600 years, was ready to slide back. But the torch had already been passed.

The seventeenth century is normally considered the time of birth of our modern science, so we have been advancing apparently for 300 years. But actually, we have been at it since the twelfth century, when the Latin translations were begun, or since six thousand years ago, when Egypt, Sumeria and Babylon began it. There may have been something before that further east, or farther south; we do not know. But certain it is that all "discoveries" came out of accumulated facts from the past.

Our approach to problem solving is perhaps our greatest contribution to science. We learned an experimental philosophy that ends the snail-shell vicious circles in which the old philosophers turned and turned. It is simple: Establish the facts by careful, direct and repeated observations. Check the facts repeatedly, one against the other. Make these the premises. Hold all variables but one constant, and find out what happens when each variable is varied alone. Draw conclusions and express them mathematically. Check the equations against the original facts. With the information thus gained, begin new experiments . . . and so on.

Here is a method of scientific procedure which leads the way out of the maze toward the new discovery. Thus our discoveries—our breakthroughs—will occur faster. But each will still be built on earlier data, earlier breakthroughs, as discoveries have always been. Inspiration is still only 1% of the answer. —EJT

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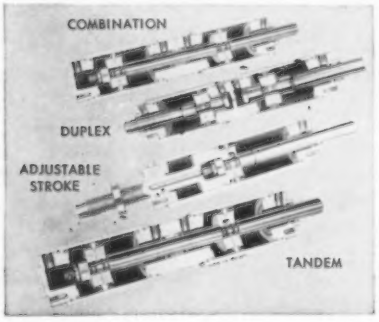

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DESIGN ABSTRACTS

Selected Papers from 1957 ASME Annual Meeting New York, Dec. 2-6

Precision Spring Clutch

The mathematical development of spring-clutch theory has appeared in various publications over a period of years, but this paper approaches previously developed mathecatical concepts in the light of recent developments. Purpose: to further present knowledge of this device. Simple construction makes economy of spring clutches worthy of consideration in the cost-conscious consumer-products field. Its reliability has caused it to find favor with precision-minded aircraft designers.

Abstracted from "Versatile New Engineering Tool—The Precision Spring Clutch," by P. C. Hungerford, Curtiss-Wright Corp., ASME paper 57-A-244.

Skew-Axis Gearing

This paper includes a description of skew-axis gear-manufacturing processes, design considerations, mounting practice, lubrication, materials and heat-treatment.

Abstracted from "Spiroid Gearing," by Woodrow D. Nelson, Illinois Tool Works, ASME paper 57-A-162.

Method for Continuously Adjustable Gear Ratios

This method for providing continuously adjustable gear ratios makes use of differential gears and speed reducers in a regular and systematic manner to provide gear ratios that can be adjusted easily with levers or electrically switched clutches. Once the desired gear ratio is selected, the input shaft is geared directly to the output shaft so that no slippage or steady-state error can occur, even for heavy loads. The system is easily adaptable to any range of desired gear ratios.

Abstracted from "New Method for Producing Continuously Adjustable Gear Ratios," by V. W. Bolie, Iowa State College, ASME Paper 57-A-146.

Development of Creativity in Engineering

These two papers discuss two different approaches to problems of seeking out and encouraging latent engineering talent. At the U. of Minnesota, accomplished designers from a manufacturing company conducted a course for senior machine-design students. Included was discussion and work on actual design problems, analysis of the problems of creative work and thinking, group techniques, instruction in three-dimensional sketching, patenting procedures, and lectures on aesthetics in engineering by an industrial designer. Additional companies are to be involved in this course, which, it is hoped, will be given twice a year.

At Iowa State College, industry and the faculty have collaborated in developing tests which, it is hoped, will help determine students' aptitude for creative machine design. The tests were planned to distinguish between creative designers and those whose major function would be working out design details, material selection and procedural problems. The tests were developed along much more specific lines than aptitude tests developed for more general testing purposes. Trial runs, involving engineers engaged in actual practice are said to have given correct classifications for 66% of all men tested, and 86% when test results were grouped according to employer.

Abstracted from "Developing Creativity in Engineering," by D. G. Taylor (Minneapolis-Honeywell Regulator Co.) and R. C. Jordan (U. of Minnesota), ASME paper 57-A-182. "The Potential Machine Designer," by J. F. D. Smith, Iowa State College, ASME paper 57-A-181.

Engineering Design and Human Limitations

These four papers present useful information on different aspects of the problems imposed by human factors in engineering design.

"Physiological Evaluation of Human Effort in Industry," by Dr. Lucien Brouha, E. I. du Pont de Nemours & Co., ASME paper 57-A-55, discusses the effect of new chemicals, radioactive substances, dust, noise, heat and cold, higher speeds. Among other recommendations, it proposes that physiological work cycles for operating new equipment be worked, along with mechanical operating programs. This would help achieve a more accurate picture of the effects of fatigue and

(Continued on page 132)

The Panelbuilder

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News for and about Panelbuilders

55 CUTLER-HAMMER OFFICES SERVE EVERY INDUSTRIAL AREA

Recently Cutler-Hammer announced the opening of new sales offices in Medford, Ore. and Louisville, Ky. With the addition of these two offices, the number of sales offices now totals 55 serving every industrial area. In addition to these offices there is a nationwide network of Authorized Cutler-Hammer Distributors who maintain stocks of motor control components. For competent assistance in the application of motor control and a reliable supply of control components, contact your nearby Cutler-Hammer Sales Office.

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Saginaw, Mich.	107 N. Franklin St.
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San Francisco 7, Calif.	2130 3rd St.
Scranton 10, Pa.	836 Jefferson Ave.
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Cutler-Hammer's Roto-Push Control Unit offers amazing opportunities for simplified compact control panel and master station design. Roto-Push combines the pushbutton and selector switch into a single control unit that will perform all the control functions which normally require two or three separate units. The control circuit is selected by rotating the knurled guard ring to the proper position, and the operation is actuated by depressing the pushbutton. The Run-Safe-Jog Roto-Push unit illustrated is typical of many common functions that normally required two or three control units. With the guard ring in the "Run" position, circuit is set up that is maintained after the pushbutton actuates the operation. With the pushbutton in the "Jog" position, the operation is actuated only as long as the button is depressed. The "Safe" position prevents accidental starting of the machine.

Circuitry Unlimited

Roto-Push operators are available in two and three position selector rings. Further there are six cam variations of the two position unit and two variations of the three position element. The double pole contact blocks that are used with the Roto-Push operators are available in any combination of normally open and normally closed contacts. Even the most involved circuits can be arranged with the Roto-Push control unit because of its wide choice of operators, cams and contact blocks. Roto-Push control Units are oil-tight and suitable for either one-hole mounting or base mounting. For further information write on your company letterhead for Cutler-Hammer Master Design Pub. EL-178.

PANEL BUILDERS HANDBOOK SIMPLIFIES SELECTION OF ELECTRICAL COMPONENTS

This handy 67 page reference guide is specifically edited to assist design engineers and control panel builders in the selection of electrical control components and control accessories. Every effort was made to make this book as concise as possible, and yet it includes such vital information as wiring diagrams, dimension drawings, ratings, ordering information and a maintained price list. Address your request for a personal copy on your company letterhead. CUTLER-HAMMER, Inc., 1332 St. Paul Ave., Milwaukee 1, Wisconsin.

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"Human Factors in Engineering Design," by Renato Contini, New York U., ASME paper 57-A-56, proposes consideration by the machine designer of some of the new and old biological and physiological disciplines, as possible sources of guidance in improving performance of machine operators.

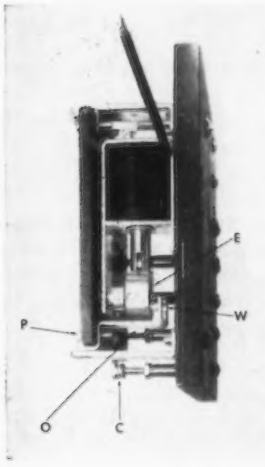
"Human-factors Responsibilities of Design Engineers," by J. L. Seminara, Picatinny Arsenal and G. A. Peters, Consultant, ASME paper 57-A-167, discusses sources of help for engineers facing problems in making their designs compatible with the limiting factors of human users and operators. Human factors, engineering consultants and other specialists are discussed. A list of printed guides and handbooks is included.

"Human-factors Engineering . . . A Working Program," by A. H. Schroeder, International Business Machines Corp., ASME paper 57-A-253, shows how one major industrial concern esablished and uses a human-factors engineering group. It also discusses why a human-factors engineering program is necessary, what some of the typical engineering problems are and how they are being solved, and the advantages of such a program. In addition, the paper includes general information about professional societies recently formed and the progress of educational programs in this field.

Other ASME Papers

For extended abstracts of five other 1957 Annual Meeting papers of particular significance in product design see Dec. 9 '57, p. 103. Two papers on photoelasticity: "Three-dimensional Photoelasticity and its application to Machine Design," by M. M. Leven and A. M. Wahl; and "New Method to Lock-in Elastic Effects," by J. W. Dally, A. J. Durelli and F. W. Riley. Two on lubrication: "Viscosity-pressure effects on Friction and Temperature in a Journal Bearing," by S. J. Needs; and "Experiments in Imperfect Lublication," by M. D. Hersey and C. W. Staples. Effect of residual stresses and external load on hardness: "Stresses Alter Hardness," by S. K. Setty, J. T. Lapsley and E. G. Thomsen.

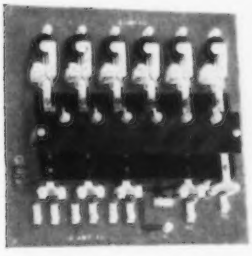
ASCO mechanically held relays are power driven in both directions with no dependency on springs or latches for operating or mechanically holding contacts



The Unique ASCO Mechanically Held Movement

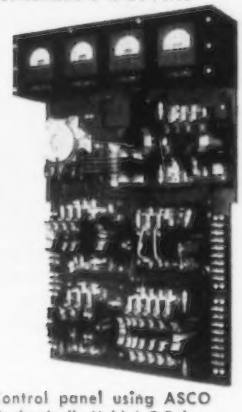
When the solenoid is energized, eccentric cam (E) is rotated. Weight drive pin (W) causes movement of operating lever (O). Lever (O) (connected to the contact finger block) rotates on pivot pin (P) and contacts such as (C) are opened or closed.

Note that with the solenoid de-energized, the entire mechanism is firmly locked in place by the angular position of the linkages—no springs, latches, or semi-permanent magnets are required!



Special ASCO Relay with 6 D-C Poles for 600 volts, 3 A-C Poles for 230 volts and 125 volts D-C control. Note Blow-outs on D-C Poles.

ASCO Mechanically Held Relays A-C and D-C . . . to 25 Amperes Combinations to 24 Poles



Control panel using ASCO Mechanically Held A-C Relays (Bulletin 1256-168). Notice multiple pole and double throw arrangements.

ASCO Power Driven Relays with No Springs or Latches:

- Provide higher contact pressures
- Minimize the possibility of contact welding
- Insure positive operation

Design simplicity is provided in ASCO Mechanically Held Relays through use of a single solenoid coil mechanism. The coil is momentarily energized during the instant of operation only. This momentary surge of power electrically operates the relay to *open and close* contacts; thus the relay is power driven in both directions, with no dependency on springs or gravity for operating and mechanically holding the contacts.

FEATURES

• No A-C hum or chatter • Operate in any position • Compact construction permits mounting on metal surfaces or panelboards • Operated by single-coil mechanism—positive in each direction • Silver contacts rigidly locked open or closed by angular relation of linkages—no delicate hooks or latches • Signal lamps require no extra contacts or control wires • Enclosed rating same as open rating due to liberal design and momentary mechanism without coil losses • All parts finished in cadmium plate or black to present good appearance and to match larger ASCO Switches.

APPLICATION

ASCO Mechanically Held Relays are used for automatic or remote control where A-C hum or chatter is objectionable, where coil loss is undesirable or where relays must not change position when the control circuit fails (low voltage release). ASCO Mechanically Held Relays are often used for master control of other control equipment, to prevent loss of voltage or control failure. These relays are frequently used for electric heaters, lighting, and similar applications.

Mechanically Held Relays are only part of the complete line of Relays made by ASCO. Our Catalog 57-S4 lists:

MAGNETICALLY HELD RELAYS

A-C or D-C . . . Normally Open . . . Normally Closed . . . Double Throw

ASCO Magnetically Held Relays use a physical arrangement which parallels that of ASCO Rocker Type Mechanically Held Relays. Since the two types are similar in appearance, they help to increase the attractiveness of control panels, at the same time offering interchangeability of contacts.

SPECIALIZED RELAYS

. . . Reverse Current
. . . Time Delay
. . . Brake Winding Time Delay
. . . Close Differential
(Voltage and Current Types)
. . . Current Type, Welding
. . . Electronic
. . . Modified Arrangements

Write for your copy of "Relays by ASCO"—Catalog 57-S4.

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RIGHT ANGLE GEARMOTOR — Horizontal or Vertical Drive, 8 sizes, ratio 6:1 to 100:1, ⅓ to 30 horsepower.

IN-LINE GEARMOTOR — Horizontal or Vertical Drive, 37 sizes, ratio 9.2:1 to 1200:1, 1 to 75 horsepower.

OUR 70th YEAR

THE D.O.James Gearmotors are of the same construction and high quality as the individual Gear Speed Reducers which we have been producing for so many years.

They cover a very wide range of ratios, horsepowers, and are an ideal, compact, efficient unit for many power and space-saving installations. They are designed and built by an organization that has been engaged in the manufacture of Gears for 70 years and that has successfully pioneered the Gear Speed Reducer to its present-day high standards.

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NEW BOOKS

Boron, Calcium, Columbium and Zirconium in Iron and Steel

R. A. GRANGE, F. J. SHORTSLEEVE, D. C. HILTY, W. O. BINDER, G. T. MOTOCK *and* C. M. OFFENHAUER, 9½ x 6 *in.*, 533 *pp. Published by John Wiley & Sons, NYC.* $14.

This fourth monograph in the Alloys of Iron Research series concludes a compilation of recent data begun in 1946 by the Iron Alloys Committee of the Engineering Foundation on seven alloying metals that became important during World War II. Two previous monographs covered aluminum and titanium; tantalum is included in the present volume.

Written by outstanding metallurgists in the field, the monograph pulls together useful engineering data showing the effects of temperature on iron and steel containing these alloys. It covers the history of the several phase systems, process metallurgy, and fabricating problems, as well as detailed property data. A separate section explores gas-turbine alloys. Bibliographies with each of the four sections are extensive.

Fundamentals of Electron Devices

KARL R. SPANGENBERG, *Prof. of Electrical Engineering, Stanford Univ.*, 6¼ x 9¼ *in.*, 505 *pp. Published by McGraw-Hill Book Co.*, 330 W. 42*nd St., New York* 36. $10.

A fundamental treatment of electron devices, including vacuum tubes and transistors, is presented here through the common denominator of semiconductor theory; emphasis is on their similar features, rather than their differences.

A basic survey of common circuit applications is also included; about 60% of the book is devoted to the devices themselves, 40% to their circuit applications.

A new approach is taken in the treatment of energy levels in semiconductors and the influence of these on junction effects, emission, and photoeffects. There is also emphasis on the analogous features of vacuum tubes

(Continued on page 137)

Cold Heading Cost Savings

Actual Cost Cuts As High As 70%

The most important consideration we can point out to the designer or purchaser of fasteners and small parts is that any part which can be machined from rod stock is also potentially available from the cold heading manufacturer. This technique offers speed of production, without scrap loss, plus superior strength and appearance for low cost and high design efficiency.

The designer need not be restricted to standard fastener sizes when they do not meet the requirements of his application. It is often much less expensive to specify a rivet, nail or screw to meet the task exactly as the application requires, than it is to compromise its function for the sake of "standards." While there is nothing mysterious about the cold heading process, experience has proved it to be of inestimable value for getting maximum quality and output at a minimum cost. While the really spectacular advantages in cost show up in runs of several thousand pieces, we are also able to take care of short run requirements. We welcome and expect manufacturers to come to us for advice and assistance concerning their fastener problems.

Given complete specifications, including a drawing and an idea of the application, we can quickly tell you whether or not it will be advantageous to have your fastener or part JOB-DESIGNED by HASSALL. The remaining important aspect of our service to you is the ability to get into production quickly and make prompt shipment.

Write for a copy of our new booklet, "What the Designer Should Know about Cold Heading".

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P. O. Box 2233
Westbury, Long Island, N. Y.

Operator places oval carbon-steel tubes in slots and presses them into headers.

Completed radiator attached to transformer.

Pre-formed ring of EASY-FLO 35 is placed in joint area.

HANDY FLUX is applied with syringe.

Holders position assembly in induction rig, induction coil is lowered, heat applied for 90 seconds; afterward joints are sandblasted to remove flux which could contaminate transformer oil.

How EASY-FLO Brazing Helps Shaw-Perkins Simplify Techniques, Cut Production Costs

Changing to silver brazing with EASY-FLO 35 brought many benefits to Shaw-Perkins Manufacturing Company, manufacturer of radiators for liquid-cooled transformers. The radiators are made up of banks of steel tubes assembled to inlet and outlet headers. Hot oil from the transformer enters at the top of the radiator and flows downward, returning to the transformer at a lower temperature.

Before Handy & Harman silver alloy brazing entered the production picture, the tubes were arc-welded and gas-welded to the headers. Now, rings of EASY-FLO 35 are preplaced and induction-brazed with results that *any* manufacturer would be happy to talk about: rework is almost nil (arc-welded joints had often failed to pass inspection), production space has been reduced (two silver brazers now do the work of six arc welders in a simplified assembly pattern), lower silver-brazing temperature minimizes possibility of unit failure in service due to metal fatigue. Radiators *look* better, have smoother fillets.

Similar benefits might well accrue to *your* product or production methods through the use of Handy & Harman silver alloy brazing. Get in touch with Handy & Harman on any phase of silver brazing. We will work with you in every way to determine the advantages silver brazing can achieve for you.

FIRST, BULLETIN 20

This informative booklet will get you off to a good start on the values, techniques and economies of low-temperature silver brazing. A copy awaits your request.

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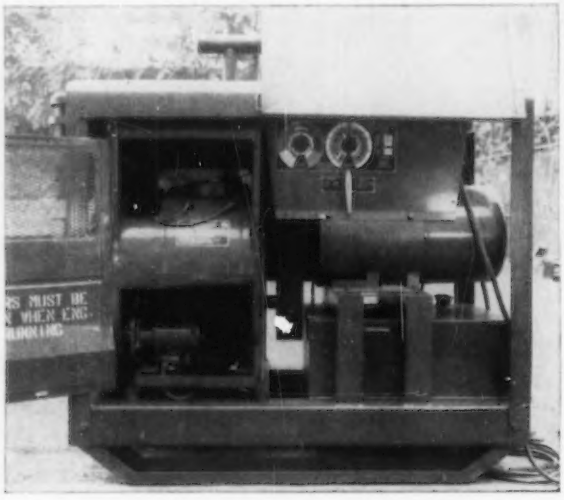
with only Minor Adjustments



with this 400 amp.
WISCONSIN-POWERED WELDER

On-the-job service is what counts most in an engine. Here, for example, is a brief summary of a service report covering the performance of the Model VR4D 56 hp. Wisconsin Heavy-Duty AIR-COOLED Power Unit which drives the 400 Ampere Arc Welder illustrated above:

"Has operated exceedingly well . . . approximately 3143 operating hours . . . maintenance has been negligible after a few minor adjustments; appreciate fact that servicing is so simple; we are free of anti-freeze . . . no fooling with gadgets of water-cooled engines."

This is another typical case of outstanding service delivered by Wisconsin Heavy-Duty Air-Cooled Engines on many kinds of equipment. Basic load-holding High Torque, heavy-duty design and construction in all details, foolproof all-weather Air-Cooling and *exclusive specialization* in the design and manufacture of AIR-COOLED Engines are some of the factors that are responsible for Wisconsin Engine preference wherever dependable, economical power is required.

You can't do better than to specify "Wisconsin Power" for your equipment. Write for Wisconsin Engine Bulletin S-212.

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 46, WISCONSIN

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- **STURDY "MARSHALLOY" CASE** . . . formed of boiler-plate-thickness steel, copper clad inside and outside to give it the corrosion resistance of solid copper. It's one third lighter, but four times stronger than cast iron.
- **PRECISION "MASTERGAUGE" MOVEMENT** . . . with such exclusive features as the coined sector gear.
- **AVAILABLE WITH STAINLESS TUBE AND SOCKET** . . . choice of stainless steels and alloys for all corrosive conditions.
- **WITH "RECALIBRATOR"** . . . quickest and best way to keep a gauge accurate.

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and transistors. Recent advances include the latest forms of transistors and photoconductive and photovoltaic cells. Numerous problems are given in the text. Eleven appendices give the origin of basic relations, and tabulate important facts. A bibliography of more than 200 references is included.

Design of Machines

ROLLAND T. HINKLE, *Prof. of Mechanical Engineering, Michigan State Univ.*, 6 *by* 9 *in.*, 188 *pp. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York* 11.

This book is primarily intended as a supplement to a standard text on machine design. It covers the field rather briefly, the author preferring to select phases of design, such as a 30-ton yoke riveter and a manual lift truck.

Career Satisfactions of Professional Engineers In Industry

Published by Professional Engineers Conference Board for Industry; 2029 K Street, NW, Washington 6, D. C. 6x9 in. 84 pp. $1.50 to NSPE members, $3 to non-members.

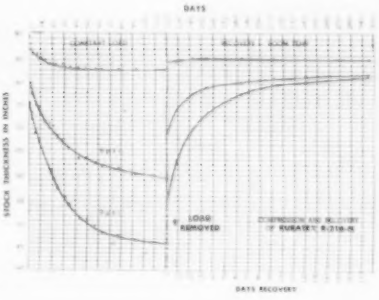
Conducted by the Opinion Research Corp., Princeton, N. J., this report is based on data from interviews with several hundred professional engineers in all the specialized technical fields of industry. The lengthy "depth" interviews were de-

(Continued on page 139)

"Excuse me, please . . . excuse me . . . I have an extra-long print here!"

Rubatex gaskets insure tight seal on L & N instruments

Insures accuracy of L&N Speedomax H Recorder-Controllers as gasketing on instrument doors.



Compression set tests run over a period of 42 weeks show how RUBATEX stocks recovered 92% to 97% of original thickness after dead load was removed—indicating the superior ability of RUBATEX to keep coming back for a longer time and to form a tight, permanent seal.

To see Leeds & Northrup instruments . . . on a foundry casting floor taking the guesswork out of pouring temperatures . . . controlling forging temperature and being subjected to severe vibration from 30 steam hammers 24 hours a day, 5 days a week . . . on countless other jobs with a wide variation in temperatures, atmosphere and usage . . . is to realize the important role of RUBATEX CLOSED CELLULAR RUBBER as an effective tight door seal to insure the accuracy of these instruments.

What's more – RUBATEX retains its shape and effective sealing qualities even though instrument doors may be opened daily for many years or sometimes left open to the atmosphere for weeks at a time.

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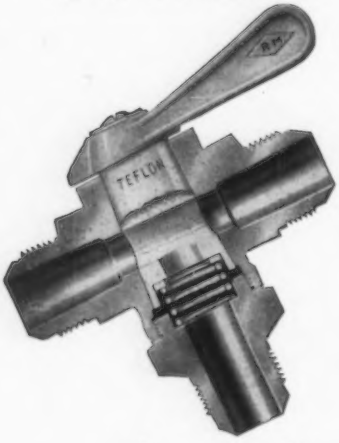
"LO-TEMP"
−65° without lubricant

"LO-TORQ"
6000 psi service



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BALANCED PRESSURE
FOR EASY TURNING

With service pressure and seals on both sides of valving disk, turning is easy. Design is simple—maintenance is low. Many services—Air, and gas 4000 psi; fuel, hydraulic oil, petroleum, water, 6000 psi. Made in bronze, semi-steel, aluminum alloy, in three different portings, ⅛" to 1". Request Bulletin No. 454.

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Teflon plug ends the need for lubricant. Easy turning—non seizing. −65° to 250°F. 2- 3- 4-way. 100 psi service. Made in aluminum alloy or stainless steel. ⅛" to 1" pipe or tube. Request Bulletin No. 754.

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signed to bring out the nonsalary career satisfactions of engineers.

Engineers in industry rate the high caliber of their colleagues, the opportunity for further training, and the opportunity for advancement as the most satisfying factors in their present jobs.

Engineers enthusiastically endorse a wide range of things management can do to foster professional recognition. They said management should keep engineers informed, ask for their ideas on relevant matters, identify their names with their work, show how their work fits into the total picture.

It is interesting to note that the engineer "doesn't have a very strong bent for engaging in the activities of professional societies; he doesn't see the need for such activity on his part, and doesn't view it as status building." Only 10% of the engineers surveyed said they are "very active" in professional engineering societies; 17% said they are "fairly active"; and the rest said they "do little or nothing in professional societies."

Concise Guide to Plastics

HARBERT R. SIMONDS, *Published by Reinhold Publishing Corp., 430 Park Ave., New York 22. 6¼x9¼ in., 320 pp., $6.95.*

A brief, but useful, introduction to each of the commercial plastics. A ready reference and quick review that includes uniform physical data on each plastic. Book also contains a list of trade names and statements from major producers.

Strength of Materials

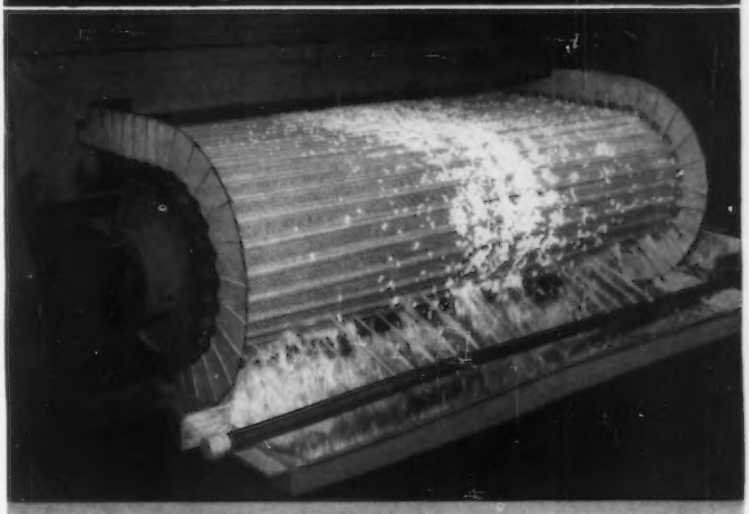
F. R. SHALEY, *U. of California at Los Angeles. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York 36. 6½x9½, 783 pp. $8.50.*

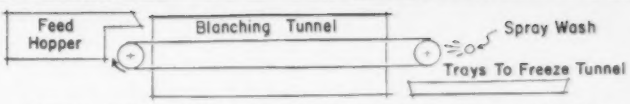
This book is designed as a first text in college courses in engineering and science. Considerable emphasis is placed on direct use of curves (such as stress-strain diagram) and on solution of problems by use of tabular computation forms.

Underlying philosophy is that of predicting actual behavior of an element or component under specified loading conditions. This eliminates any need for detailed discussion of factors of safety, working stresses, etc.

(Continued on page 140)

Cambridge WOVEN WIRE BELTS





TYPICAL INSTALLATION FOR AUTOMATED BLANCHING AND WASHING

Continuous processing on open mesh belts increases product uniformity

Open mesh Cambridge Woven Wire Belts allow liquids, gases, cold or heat to flow freely through the belt and around the product for fast, uniform processing. Metal parts, food, chemical or ceramic products carried through wet, dry, hot or cold processing operations on endless Cambridge belts means increased production and lower operating costs. Here's why:

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SPECIAL SURFACE ATTACHMENTS AVAILABLE; raised edges, cross flights to keep product on belt during inclined movement.

Whether you design machinery for your own use or for resale, your Cambridge FIELD ENGINEER can explain how the many advantages of Cambridge belts make automated processing practical and economical. And, he'll recommend the belt size, mesh or weave— in the metal or alloy—best suited to your operations. Call now. He's listed in the classified phone book under "BELTING, MECHANICAL". Or, write for FREE 130-PAGE REFERENCE MANUAL giving mesh specifications, design information and metallurgical data.

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Synchronous and Induction Capacitor Type Motor

Approximately 2½" in diameter, the R-25 is available in either induction or synchronous construction with reversible rotation.

Typical applications are in recording instruments, dictating and adding machines. Available with gear case speeds from ½ to 3600 RPM, torque ratings up to 75 oz. inches or higher, and single, 2 or 3 phase.

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Such matters are more or less empirical and differ widely between various branches of engineering. Sufficient information is included to make the student understand these differences and recognize the need for factors of safety or their equivalent.

Because of recent progress in the physics of metals, inelastic behavior, buckling phenomena, fatigue of metals, it has been possible to present, in a simple but scientific way, a number of subjects that have usually been treated only in advanced courses. For example, simple engineering methods of predicting inelastic behavior under combined stresses are included. A general method of predicting buckling loads for inelastic eccentric columns has been developed. A method of design for repeated loading under stresses of variable amplitude is presented, including stress-concentration effects. All these subjects can be understood and applied without recourse to mathematics beyond calculus.

Magnesium Casting Technology

A. W. Brace and F. A. Allen, *Published by Reinhold Publishing Co., 430 Park Ave., New York 22. 174 pp, 6x9 in.* $4.95.

This one-volume summary of magnesium casting metallurgy is a handy reference book for those familiar with the industry, and a basic text for those who aren't. Contents include alloys, melting practices, sands, types of casting processes, heat treatment and applications. Magnesium founding prac-

(Continued on page 141)

"I liked your design, Johnson. Management liked it; Production, Sales and Promotion all liked it. The only trouble is that 160 million consumers didn't like it."

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cut costs, simplify assembly

Precision-engineered Industrial Retaining Rings . . . internal, external and open types . . . are available in a wide selection of sizes and finishes. Solve your fastening problems simply and economically with the rings that cut machining and tooling expense, save material, simplify and speed assembly.

Series 1000 and 2000 are available *stacked* for quickest application.

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tices have not changed basically in the last 10 years.

The English terms used and practices described are interesting and well presented. The American industrial practices are also well covered—by contributors from this country. The book is written in the lengthy jargon used by many engineers who are not writers.

Diazotype and Blueprint Paper Standards

Simplified Practice Recommendation R 260-57, effective August 15, 1957. Available from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 5¾x9, 8 pp. $0.05.

The purpose of this recommendation is to establish standard sizes of diazotype and blueprint paper and enable the sensitized-materials coating industry to improve its service to consumers. Recommendation covers standard sizes of sheet diazotype paper and standard widths of diazotype and blueprint paper in rolls.

Essential Strength of Materials

Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36. 8 x 5; 261 pp. $4.75.

This little book was written for use in strength-of-materials courses that emphasize the applied and practical rather than the abstract and theoretical. Also it is designed for the student who does not know calculus.

Now, of course, there must be hundreds if not thousands of books written with a similar aim. Will this book be a useful guide in the jungle of knowledge? It should. It has good presentation, clear diagrams and type, good paper and size, and author integrity. It is one of those that are chosen without hesitation after a quick flip-through. It should prove to be a good guide.

Sixth Symposium on Combustion

Published by Reinhold Publishing Corp, NYC. 10 x 6¼, 943 pp.

The headings of this book's main divisions are: Structure and Propogation of Laminar Flames, Structure and

(Continued on page 143)

ADVANTAGES OF FLEXIBLE SHAFTING

For Power Drive and Remote Control

by C. Hotchkiss, Jr.
Application Engineer,
Stow Manufacturing Company

Flexible shafting has the following advantages over other type drives:

1—it is often the simplest method of transmitting power between two points which are not collinear or which have relative motion

2—eliminates exposed revolving parts

3—does not require accurate alignment

4—easy to install and maintain

Not Collinear—Where it is necessary to connect two shafts which are not collinear, a simple arrangement of a single belt or two universal joints will often do the job adequately. But, in many cases where the path of transmission is more complicated and would require a more expensive arrangement of mechanical components, flexible shafting provides a simple, low cost, efficient drive which is easy to install because it does not require accurate alignment. See example, figure 1, in which a 1¼ inch Stow flexible shaft is used to drive the auger on a G.L.F. bulk feed truck.

Flexible shafting also allows the designer greater freedom in locating either the drive or the driven component on a piece of equipment.

Fig. 1

Relative Motion—Where two shafts which have relative motion must be connected, flexible shafting is often the ideal means of transmission. In many cases it eliminates a much more complicated drive which would, necessarily, include telescopic joints; further, it eliminates the danger of exposed moving parts. See figure 2, which shows a ¾ inch Stow flexible shaft driving an Avery Rake built by the Minneapolis Moline Company.

Fig. 2

Other typical applications of this type are used on portable power tools when motors are too heavy to be mounted on the tool—such as portable grinders, sanders, paint scrapers, saws and tree tappers. And, since flexible shafting is not affected by vibration, it is an ideal drive for applications where a high degree of vibration is involved—such as in vibration testing tables and concrete vibrators.

Stow flexible shafts are available: for power drive applications in diameter sizes from ⅜ inch to 1¼ inches; for remote control applications in diameter sizes from ⅛ inch to 1⅝ inches. The 1¼ inch power drive shaft will transmit up to 10 HP while the 1⅝ inch remote control shaft will transmit up to 4000 lb. in.

For complete engineering data on flexible shafting, including selection charts, write for engineering Bulletin 570.

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This book has much to interest combustion engineers, and should be valuable. In fact any engineer would be intrigued by a glance through its profusely illustrated contents.

American Drafting-Standards Manual

Sections 1, 2, 4 *and* 5. *Published by ASME*, 29 W. 39*th St., New York* 18. 8½x11 88 *pp. inclusive.* $6.

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"Here's the switch design for our perpetual-motion machine."

MICRO-BEARING ABSTRACTS

by **A. N. DANIELS**, *President*
New Hampshire Ball Bearings, Inc.

BEARING FITS AND FITTING PRACTICES

As shown in *Fig. 1*, the fitting of Micro-Bearings, like the fitting of larger ball bearings, chiefly involves the clearances between the inside diameter of the housing and the outside diameter of the bearing; the bore of the bearing and the shaft diameter.

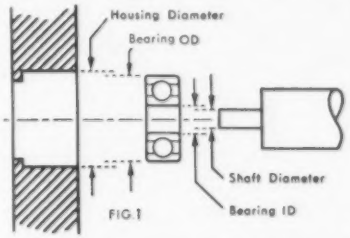

FIG.1

The achievement of the desired fit by dimensioning is illustrated in *Fig. 2*. The bearing ID is represented by the top blocks and the shaft OD is represented by the lower blocks. Such a block diagram could also be applied to housings and bearing outside diameters. In this block diagram, it will be noted, the bearing ID is represented by a .00015 tolerance with a similar tolerance for the shaft. A resulting fit of line to line to .0003 loose is shown.

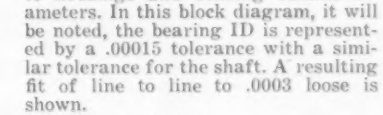

FIG.2

An interference fit not tighter than line to line is suggested for the following reasons:

1. *Difficulty in assembly.*
2. *Difficulty in disassembly. This is often more hazardous than the assembly operation and may result in total bearing destruction.*
3. *Reduction in radial play.*
4. *Danger of bearing ring conforming to possible poor geometry of mating shaft or housing.*

TOLERANCE DISTRIBUTION

The maximum .0003 loose condition shown in *Fig. 2* may be excessive in some applications. The fitting problem then resolves itself to reducing this extreme, and yet maintain the maximum tight fit of line to line. The looseness may be reduced by redimensioning the shaft to .12490/.12475 as shown in the block diagram, *Fig. 3*.

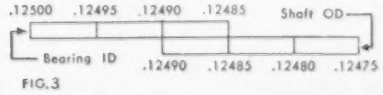

FIG.3

If the frequency distributions of shaft and bearing ID sizes were statistically normal, the modal fit of all parts would be 0.0001 loose. Accordingly, an insignificant percentage of parts would be mated to the extreme values, and for practical purposes could be ignored.

With regard to bearings' outside diameters and bores, however, normality of the distribution curve cannot be assumed. During the grinding operation, the "most metal tendency" tends to skew the frequency distributions for bearing ID's and OD's in the direction of most metal.

In grinding and finishing shafts and housings, similarly skewed distributions occur.

Operating on a modified probability distribution of tolerance is possible if the volume of parts is sizeable. But the approximate distribution of shaft and housing sizes must be verified if this method is to be used.

MATERIALS and SURFACE FINISHES

The ease of assembly is also affected by materials and finishes. The following factors must be considered:

1. *The galling characteristics, hardness and ductility of the materials involved.*
2. *Finish lay patterns produced by various tools and techniques used.*
3. *R M S surface finish values achieved.*
4. *Geometry of shafts and housings as regards out-of-roundness, taper, etc.*

The possible combinations of these elements in any single application are so numerous that their gross effect can only be ascertained by trial and error, or by a detailed study of operations on individual applications. A more complete discussion of fitting practices, including sizing methods and coding, is found in our design handbook.

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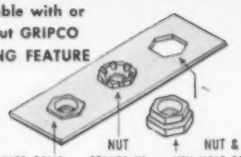

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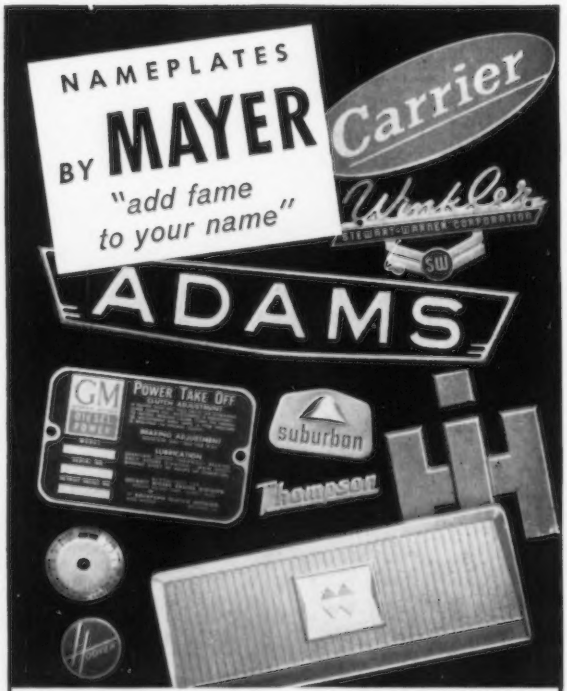

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PRESS PREVIEWS

Navy Developing New Cooking Gear for Subs

The Army travels on its stomach —so does the Navy. At a recent press tour of the Commissary Research div. of the Navy's Supply Depot, Bayonne, N. J. we were privileged to see the extent of research insuring the best foods prepared by the most modern kitchen equipment for our growing nuclear submarine fleet. Aside from studies of concentrated foods (compressed flour, dried fruits and vegetables, and preprepared meats) the Navy is finding out the best way to design food equipment to meet the restricted requirements of a submarine.

- Oven size is close to the volume of the meat, thereby reducing meat losses from a normal 37% to 17%.
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(Continued on page 146)

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"unimike" (picture on p. 145). Designed for submarine use, it provides in a 28-in. square a heavy-duty food mixer, potato peeler, steam kettle, pressure cooker, refrigerated kettle, meat grinder, and vegetable slicer. It will also do some types of oven baking and roasting.

RCA Ferrite Production to be Centralized

All RCA activities in special ferrites, used in electronic computers, will be concentrated at the company's Needham Heights, Mass., labs. These labs have been primarily a ferrite advanced-development activity; manufacturing is located at the Camden plant. While development activities will be continued, the labs will now be expanded to include product design and manufacture of special ferrite products, such as squareloop memory cores, aperture plates, and switch cores.

Steel Division to Expand

Calumet Steel Div. of Borg-Warner Corp. has completed plans for a multimillion-dollar expansion and improvement program at its facilities in Chicago Heights, Ill. The program, largest ever undertaken by the division, will be divided into two stages. The first will increase capacity by at least 40%, improve product quality, broaden the product line, reduce costs, and make possible 24-hour-a-day operation.

Under this phase Calumet will

(Continued on page 147)

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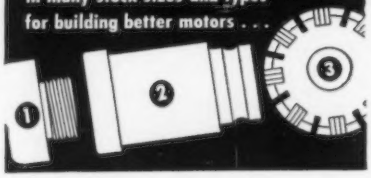
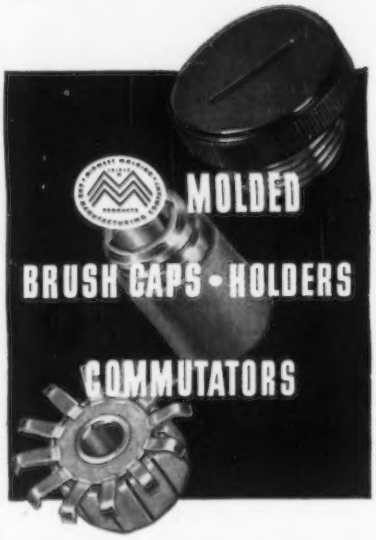


Design engineers and production planners use MMM as a dependable source for all 3 motor parts; available stock dies permit some variations in finish and materials.



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build a combination rail, axle, and billet-heating furnace, a new roll-conditioning and machine shop, a new fence-post finishing shop, an expanded merchant-bar finishing and reinforcing-bar fabrication shops, and additional stands and tables for the present 14-n. rolling mill. In addition, there will be tube-mill improvements, relocation and rearrangement of the material yard, and other betterments.

This phase of the program is scheduled to be completed by December 1959.

The second phase, for installation of electric furnaces and additional rolling and finishing facilities, is scheduled for completion by mid-1961. Purpose of this part of the undertaking is to broaden the division's market base and add new billet-steel products to the line.

Belock Opens Engineering Center in New York

An engineerng center, primarily for the development and production of guided-missile and weapons-control systems, has been opened by the Belock Instrument Corp., College Point, N. Y. The new center occupies 30,000 sq ft of a recently constructed air-conditioned building. As part of the expansion plan, the added unit provides the company with 46,000 sq ft for its engineering facilities that include an extensive environmental-testing laboratory.

New Western Refining and Fabricating Plant

To expand company operations and services to meet the needs of West Coast arts trades and industries, Handy & Harman, fabricators and refiners of precious metals, is building a new plant in El Monte, Calif. Complete with office, lab, refinery, operating area and warehouse, the plant will cover more than 23,000 sq ft. As the company's fifth plant, it is scheduled to begin operating in February 1958. The Los Angeles plant then will close.

The lab will be equipped for precision analysis and weighing of gold, silver, platinum and other metals. The refinery will be geared for effi-

(Continued on page 149)

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ELECTRONIC and POLARIZING	Maximum coercive force . . . Almost infinite electrical resistivity . . . Highly resistant to demagnetization by driving field . . . Negligible eddy current losses . . . Less heating . . . Unaffected by strong magnetic fields . . . Easily designed for simplified holding fixtures . . . Often practical in more favorable shapes for equipment design improvement.
Such as MAGNETIC FOCUSSING OR DEFLECTION OF CATHODE BEAM TUBES . . HIGH FREQUENCY ALTERNATORS . . ION TRAPS . . SONAR DEVICES . . TRANSDUCERS . . LOUDSPEAKERS, etc.	
MISCELLANEOUS	Non-conductors . . . Do not cause unwanted current paths when placed close to circuit-interrupting equipment. . . . Simplify equipment design . . . Linear energy variation and retrace with temperature increase and decrease.
Such as LIGHTNING ARRESTERS, ARC SNUFFERS, TEMPERATURE-SENSITIVE DEVICES, and other equipment.	

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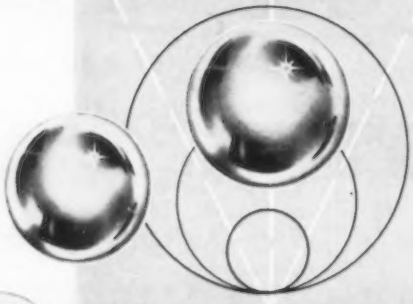

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First U. S. Plant to Produce Polypropylene

A large commercial polypropylene plant was expected to be on stream December first, according to Hercules Powder Co. officials. The plant, at Parlin, N. J. is the first commercial polypropylene plant in North America, and will have an annual capacity of 20 million lb. While demand for this new product will be heavy, company officials are confident that after the usual plant shakedown adequate quantities will be available for introductory distribution starting the first of the year. The introductory price will be 65¢ per lb, but over the long term large-scale operating economies should make the price fully competitive with that of other plastic materials.

It is expected that polypropylene will complement the usefulness of Hi-fax, Hercules' high-density polyethylene.

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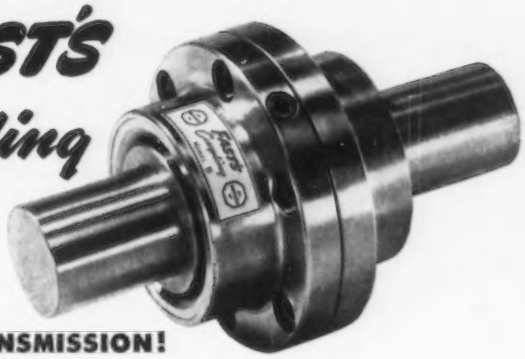

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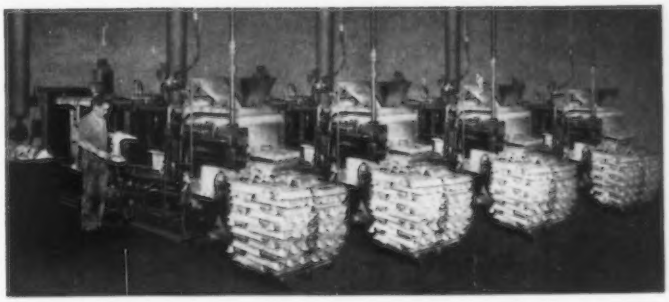

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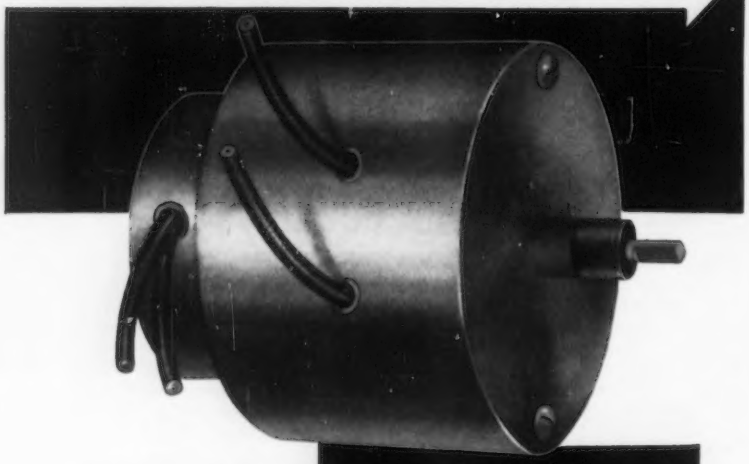
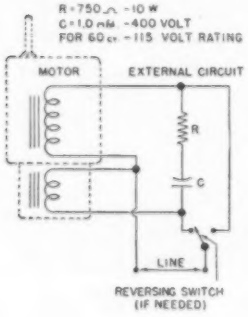


WIRING DIAGRAM

Designed to operate on 115 v. 60 cycles. Supplied with 6" leads. Guaranteed starting torque 80 inch ounces. External phase shifting circuit is required.

NOTE: If UL approval required—specify Bristol Series 530 motor developing 40 inch ounces.



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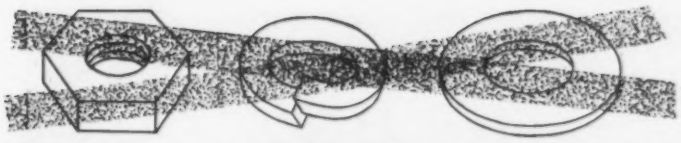

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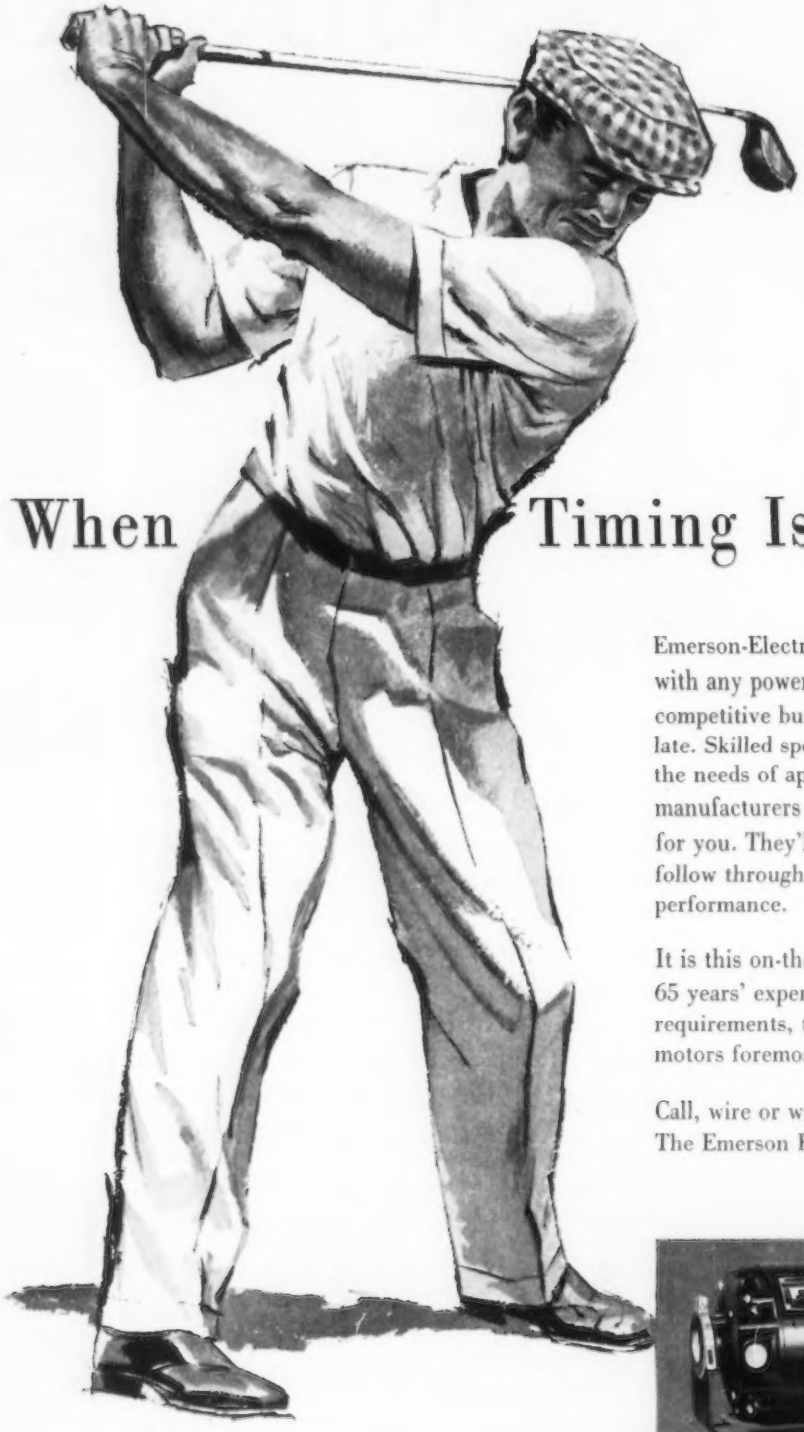

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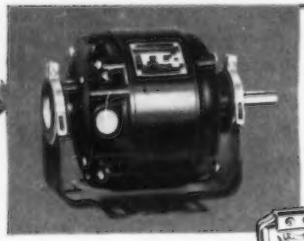

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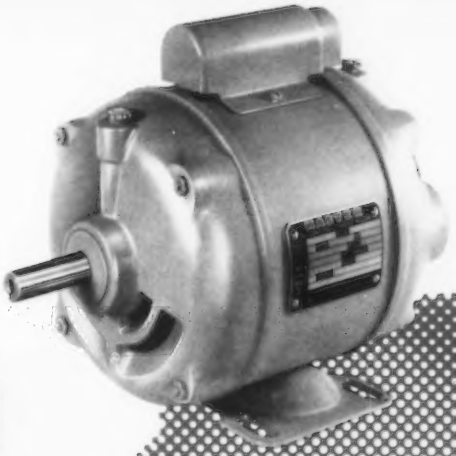

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